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REFINER
AND NATURAL GASOLINE MANUFACTURER

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The Look Box

Outlook Good

THE outlook for the oil industry still must be regarded as generally promising, despite the fact that the air has been charged lately with foreboding, generated by the widespread labor troubles and the indications of recent and impending leveling off of the hitherto sharply rising business trends.

If there are circumstances today that do not augur well for the oil business, they are primarily the general circumstances that affect all business, rather than factors involving the oil industry itself and its individual position.

If business in general has before it a less successful course than in the past, the oil business likely will not be able to escape completely the adverse conditions.

But in the absence of an important set-back or recession in general industrial and commercial activity, the oil companies probably will continue for some time to experience profitable operations.

Furthermore, if the much talked about impending business lull of the next several months materializes, the oil industry should prove less vulnerable to it than many other industries; and even if the present period should prove to be the beginning of a major recession of business, it likely would be considerable time before the oil industry would be adversely affected, because of the remarkably strong position that the industry now occupies.

The industry's inventories of oil are the smallest for many years, and its markets consequently are unusually strong, basically. There are not hanging over the market any excess supplies of either crude or refined oils that might seriously impair the existing price structure.

Even if there should develop excessive production of crude or unwarranted operation of refineries, the industry could for some time absorb the excesses in its storage tanks and still not have much more than needed working stocks.

Opinion differs to some extent, naturally, as to how much oil is needed above the ground to maintain free movement from the well to the service station. But it is generally conceded that the present inventories are not much if any above minimum requirements with crude stocks around 307,000,000 barrels, and with stocks of refined oils well in line with the current consumption.

Some qualified commentators say that crude stocks should not be permitted to go much above 300,000,000 barrels, but others think the total could be pushed to 325,000,000 barrels without adversely affecting the industry's position and markets.

Furthermore, it is promised that the industry will continue for some time to hold this exceptionally favorable inventory position, as the new supplies of oil are being balanced closely with market demand,

while a continuation of such balance is indicated at least for the next several months.

During June particularly successful results were being achieved in balancing crude production with market demand. It is indicated that the crude stocks were but slightly changed at the end of the month, as compared with the beginning of the month. Official figures show that in the first half of June there was only a minor addition to the crude stocks.

This success in the control of crude production in June was encouraging, following the ineffective control and heavy additions to storage in the preceding four months.

Continuation of the success is in prospect, moreover, at least until August 1, as the leading producing states contemplate further strict control in July. The conservation officials of some of those states already have prescribed allowables closely conforming with the forecasts of demand by the Bureau of Mines, and others have intimated they will take similar action.

While the inventories of crude oil are very moderate and likely to continue so in the next several months, the inventories of refined products similarly are at economic levels.

Stocks of finished and unfinished gasoline in the United States showed a further decline of 422,000 barrels in the week ended June 19, dropping to 76,574,000 barrels. The heavy demand for gasoline has caused the industry to take out of storage 7,000,000 barrels since the stocks reached their all time peak in late March.

The inventories of 76,574,000 barrels on hand June 19 were 10.6 percent greater than those of 69,214,000 barrels held one year previously. But such an increased supply is warranted by the gain that has occurred in the demand for motor fuel. In the first four months of this year, the total domestic demand for gasoline was 11.4 percent larger than in the similar period last year. In May and June the gasoline consumption apparently was more than 10 percent greater than in those months last year, and for July the Bureau of Mines has forecast that gasoline demand will be 12 percent larger than for July last year.

The inventories of other refined oils similarly are at justified levels. Gas and fuel oil stocks, for instance, are shorter than at this time last year, while demand for those oils has been running substantially higher this year than last year. The stocks of 99,215,000 barrels June 19 compared with 104,728,000 barrels a year before. The fuel oil market has reflected this comparatively small inventory lately in rising prices. It appears that fuel oil will bring attractive prices next fall and winter.

While effective balancing of supply of oil with market requirements and the desirable inventory situation have combined to make the markets stable and the prices favorable, the oil industry has been benefiting also by the amount of the demand for petroleum this year, about 11 percent higher than last year and the greatest for all time.

The oil companies thus have been receiving satisfactory prices and also have been doing record volumes of business. Those factors explain why earnings in the first half of 1937 ran probably more than 50 percent above those in 1936, and were around the levels that prevailed in 1929.

While it is indicated that there will be a continuation, at least for several months, of the present successful balancing of production with demand, it likewise is indicated that the demand for petroleum will continue heavy in the next several months.

The season of vacations, extensive motoring, and heavy consumption of gasoline now is under way, and business volumes of oil companies will be seasonally large in the next few months. Furthermore, it is indicated that the sales of petroleum products this summer and early fall will show more than the usual seasonal expansion, as recent surveys foreshadow unprecedented travel by motor and otherwise in this year's vacation period.

More automobiles are registered now than ever before, and the owners this summer are disposed more than in recent years to travel during the vacations.

Business people in all lines catering to tourists are making plans for accommodating record volumes of trade. A substantial part of the expenditures of the millions of persons seeking recreation will be made at the service stations.

To meet the unprecedented demand for motor fuels, increasing demand for lubricants and the indicated increase in consumption of furnace and fuel oils, the refining branch of the industry is actively continuing widespread work in plant modernization, installation of new plants and new processes, virtually throughout the world. This undiminishing activity in construction got well under way over a year ago, and there is as yet no sign of its abating. Not only is the industry engaged in modernization of its distillation and cracking facilities, but it has begun to rapidly adopt the various polymerization processes now available, the various processes and systems for synthesis of extremely high octane rating special fuels, and it continues activity in the installation of solvent-extraction systems and solvent-dewaxing processes for the manufacture of improved lubricants. Company financial statements are constantly revealing managements' determination to keep their plant properties abreast of the times either through improvement of existing facilities or through the replacement of obsolete processes with the highly efficient modern equipments and systems. Not only is this true in America but virtually all of the petroleum refining industries established of late years in most foreign countries continue to expand or to replace old equipment with the more recently developed modern methods and machinery.

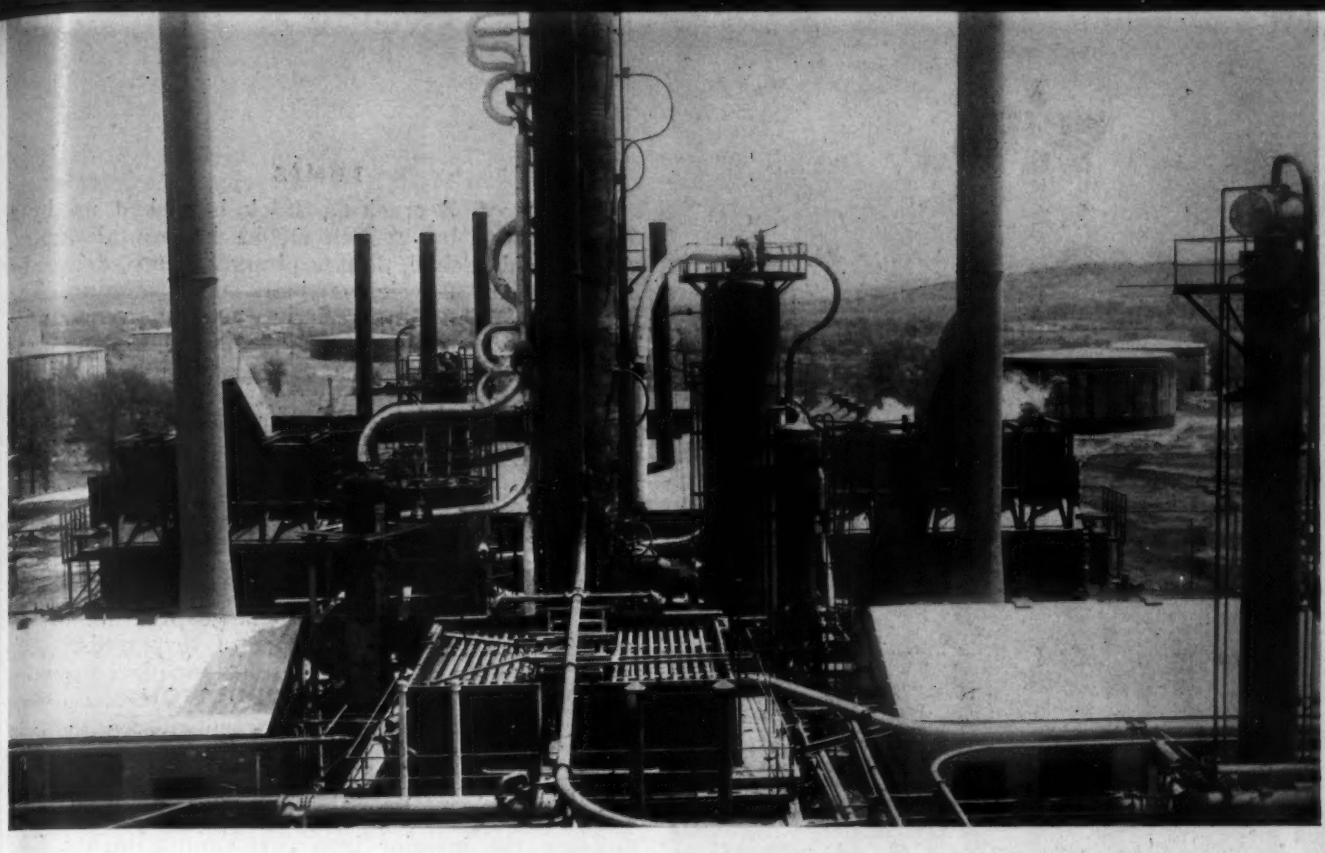


FIGURE 1

Johnson Oil Refining Company's recently completed Dubbs cracking unit at Cleveland, Oklahoma.

Description

Of Design and Operation of Johnson Oil Refining Company's

New Cracking Plant

WM. J. LEENHOUTS
Superintendent

JOHNSON Oil Refining Company, Cleveland, Oklahoma, recently put into operation a new Dubbs cracking plant and can boast of one of the most up-to-date cracking units in the Mid-Continent. This investment and improvement is an encouraging sign of the company's faith in the industry. Rapid strides have been made in the last few years in the design of cracking plant equipment and the new unit bears very little resemblance to units of similar type erected 5 or 10 years ago, when design and efficiency is considered.

The problem which has been most annoying on the former type of units has been one of keeping the units on stream for any great length of time. As the Johnson Oil Refining Company designed its plant for long cycles of operation ranging from 30 to 60 days, a number of different setups for cracking were considered before deciding on the present unit.

It has been known for some time that all charging stocks canot be cracked under the same conditions of time and temperature. Some oils, even in the same process, require relatively low temperature with short time while others may require high temperature with long soaking time. There is, therefore, a preferred design and arrangement for each type of cracking process. Greater yields of high octane and better quality gasoline are being secured by selectively cracking topped crude and other stocks.

Selective cracking units are economically designed with two or more cracking furnaces and a combined secondary system in which the light and heavy fractions of fresh feed and recycled stock are segregated for charging into separate coils. The present unit is a two-cell selective cracking unit with stabilization and absorption equipment, having a capacity of 2,500 barrels per stream day.

FLOW THROUGH PLANT

In order to get an idea of the design of the new cracking unit it will be necessary to follow the flow of the oil through the plant. Part of the topped crude is used as an absorption medium before entering the cracking plant proper. Topped crude is pumped over the top of the absorption tower, going down the tower counter-current to the rising gases. All gases made on the new unit are passed through this absorption column. The dry residue gas leaves the top

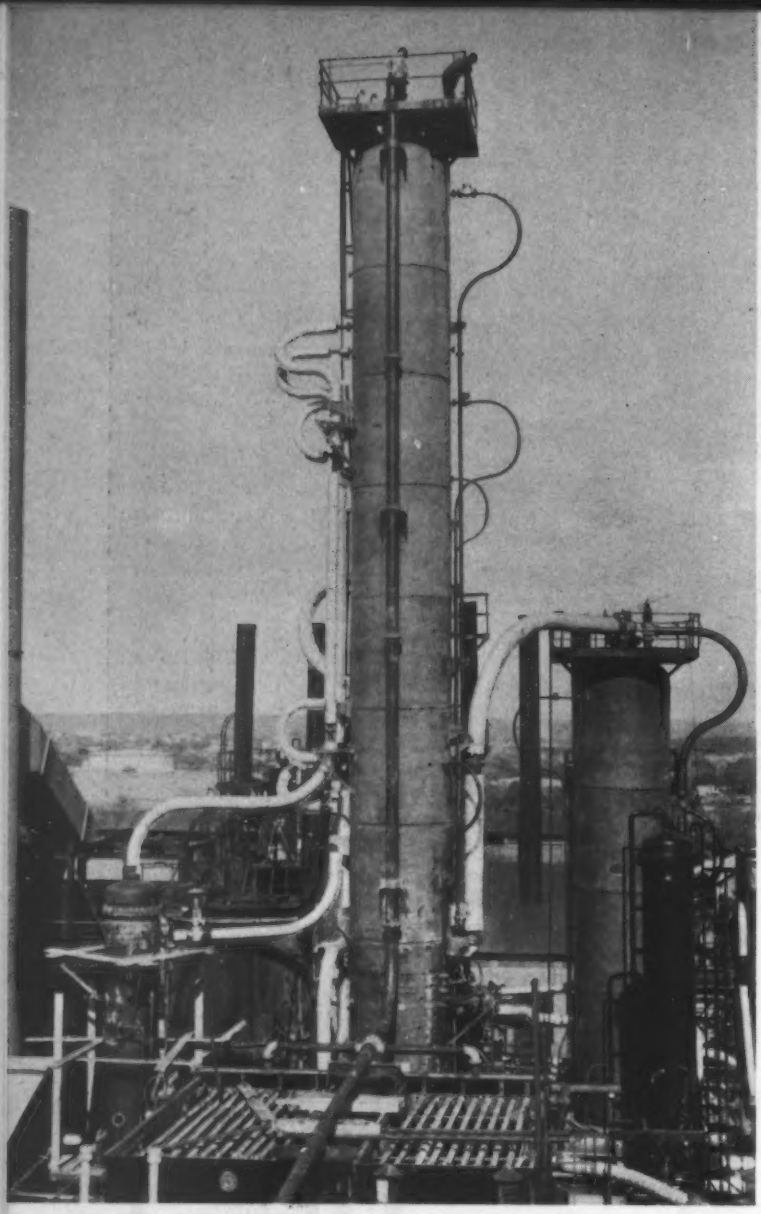


FIGURE 2
Details of main fractionating column and flash chamber are shown.

of the absorption column ready for use as a refinery fuel. The furnaces are heated by the gases made in the process of cracking. The gas-saturated topped crude, together with the remaining topped crude, is then pumped into the main fractionating column.

The main fractionating column is a vessel 7 feet in diameter by 73 feet in height. The tower has a working pressure of 95 pounds and an operating pressure of 75 pounds with a temperature range from 350 to about 800°F. The tower contains 26 trays, the top section being filled with bubble trays and the lower section with side-to-side trays. Several streams are removed from the fractionating column.

At this time we are only interested in following the two charging stock streams which are taken off from the bubble tower. The topped crude is pumped on the seventeenth tray of the tower and flows downward and counter-current to the hot cracked vapors from the unit. These hot vapors going up the tower segregate and fractionate the recycled stock and the topped crude into two distinct cracking fractions—one a heavy-oil fraction of about 18 to 19 gravity, which is taken from the bottom of the fractionating tower; the other fraction is taken off from the reservoir at the twelfth tray of the fractionating tower and is a light-oil cracking stock of about 24 to 26 gravity. This charging stock has a boiling range between 400 and 600°F.

PUMPS

The heavy-oil cracking stock is picked up by a 5¾-inch bore by 18-inch stroke horizontal duplex, outside end-packed, double plunger pump, driven by a 3-cylinder, 4-cycle vertical Diesel engine. The capacity of this pump is 256 to 360 gallons per minute at a temperature of 685 to 750°F. The pump is capable of working at a discharge pressure of 700 pounds and has a suction pressure of 70 pounds. The pump has water-cooled glands, plunger, and pedestal and the liquid end is made of a solid forged-steel billet.

The light hot-oil pump is similar in construction to the heavy-oil pump save that it has a 4½-inch bore and an 18-inch stroke. It has a capacity of 138 to 187 gallons per minute at a temperature of 570 to 630°F. It is capable of giving a discharge pressure of 950 pounds with a suction pressure of 70 pounds.

FURNACE CONSTRUCTION

Now follow the course of the oil from the hot oil pump to the heavy oil furnace. The furnace is a center wall, updraft, radiant type having a fire wall which extends through the full length of the furnace, dividing the interior into two compartments. The side wall and roof are of refractory tile construction and all the tile are suspended and held in place by hangers bolted to the structural steel work of the furnace.

The refractory tile is backed with 2 inches of insulation, an air space and then one eighth-inch steel flashing. The oil through the furnace is in two parallel flows—one in each compartment. The furnace is capable of handling 6,500 barrels of new charge and recycled stock per stream day. The inlet pressure is about 500 pounds and 685° F. The outlet pressure is about 250 pounds with a temperature of about 935° F.

The charge into the furnace is divided into two equal parallel streams through each half of the furnace. Each stream passes downward through the convection section which consists of 52 tubes 3¼ inches outer diameter by 2½ inches inner diameter, then through the radiant shock tubes of the roof of the furnace, of which there are 12 in number and are 2¾ inches outside diameter by 2¼ inches inside diameter, then through the radiant wall tubes which are 36 in number and are 2¾ inches outside diameter and 2¼ inches inside diameter.

The furnace is fired by 20 gas burners which are set in the floor of the furnace close to the center wall. The gases go upward at such an angle that the flames impinge against the projected fire brick which are set in a staggered fashion in the center wall. The course of the gases is upward along the center wall through the roof tubes and through the convection sections into the breeching of the stack.

The furnace is a radiant type heater. By this we mean that 70 to 75 percent of the heat is absorbed in the radiant section of the furnace. In the company's former type furnaces, heat was absorbed almost entirely in the convection section. In this radiant type furnace heating must be so arranged that the tubes are out of the path of the hot or burning gases. Flame impingement on tubes will cause overheating of the tubes with resultant coking and loss of tubes.

In the new type of furnace combustion in the radiant section takes place without flame impingement. The direction and velocity of the flue gases is controlled and uneven heating is eliminated. For the best results and long runs while cracking heavy oil the time element under high temperature should be reduced to a minimum and the oil brought quickly and uniformly up to a maximum desired temperature at the outlet of the furnace.

HIGH VELOCITY

This high velocity of oil through the tubes is accomplished by the hot-oil pump. The heavy hot-oil pump allows a pressure drop through the furnace of more than 250 pounds. This pressure drop causes a very rapid passage of the oil through the tubes.

Although the design of the light-oil furnace is similar to the heavy-oil furnace, the flow of the oil through the furnace is slightly different. The charge is pumped through the convection section of the heater in two equal parallel streams. These streams are then combined at the outlet of the convection section and flow in series through the left side or radiant section of the furnace, starting from the bottom upward then across through the radiant roof section tubes and then down the right side wall tubes which make the soaking bank of the furnace. Since the left side of the furnace contains the soaking bank, it can be fired separately and the temperature can be independently controlled.

The light-oil furnace is capable of handling 3,500 barrels of light recycled stock per stream day. The inlet pressure to the furnace is approximately 900 pounds and the oil has a temperature of about 570°F. The outlet pressure of the furnace is 600 pounds per square inch and the temperature is about 985 to 995°F.

This two coil, two furnace hookup permits the operator to bring each type of charging stock to the most desirable temperature and conditions for cracking. If the light and heavy oil charging stocks were circulated through a single furnace coil to a temperature of 990 to 995° F., the heavy oil would coke in the tubes, causing a shut down, or if heated only to 930 to 935 degrees, the light oil would recycle several times without much cracking.

The streams from the light- and heavy-oil furnace, which run 995 and 935° F., respectively, are combined into common transfers before entering the reaction chambers. The two reaction chambers are both 3 feet 6 inches in diameter and 25 feet long. One has a wall thickness of 2½ inches and is good for a working pressure of 530 pounds and the other is 1¼ inches wall thickness and is good for 260 pounds working pressure. The reaction chambers give the cracking stock a longer period at a high temperature. The cracked stock goes into the top and out of the bottom of the reaction chamber. After this material leaves the reaction chamber the pressure is dropped to 75 pounds as it enters the flash chamber.

FLASH CHAMBER

The flash chamber is 7 feet 6 inches in diameter by 32 feet 6 inches in length, 1 inch in thickness and good for 95 pounds of working pressure at 850° F. In the flash chamber takes place a separation of the cracked vapors and the residual fuel oil. The vaporized fractions pass out of the top of the chamber to the main fractionating column and the heavy residuum flows from the small pot in the base to a 10 x 5 x 12 hot oil pump which, in turn, pumps it through the residuum cooler, and thence to the storage tank.

The fluid level in the flash chamber is held constant by a float control in the bottom of the flash chamber and only a small amount of oil remains in the chamber at one time. The fuel oil from the plant is a residuum of Bunker C, specifications. This fuel can be cut back with a fraction taken from the main bubble tower, thus making a lighter grade of fuel oil.

Now we return to the main fractionating tower where we originally started with the topped crude. The topped crude originally was pumped on the seventeenth tray of the fractionating tower and the cracked hot vapors are discharged into the bottom of the fractionating tower. These vapors pass up through the fractionating tower and as they do so are fractionated into various types of distillates, fuels and charging stocks.

Several streams can be taken off from the main fractionating tower. First of all, a stream of unstabilized end-point gasoline is taken off overhead. The temperature in the top of the tower and the end-point of the gasoline is controlled by means of a reflux pump which pumps cold pressure distillate over the top of the tower, thus controlling the temperature of the vapors leaving. The plant can be operated so as to make only end-point gasoline, residuum fuel and gas but it is also possible to take off various side cuts as the market may demand.

From the seventh tray of the fractionating tower it is possible to take off a side cut of tractor distillate. This material is finished in a side stripper column which is 42 inches in diameter and 22 feet long. This same side stripper column can be used in making No. 1 or 2 furnace oil by taking a side cut

FIGURE 3

View of the two furnaces used in this selective cracking process.

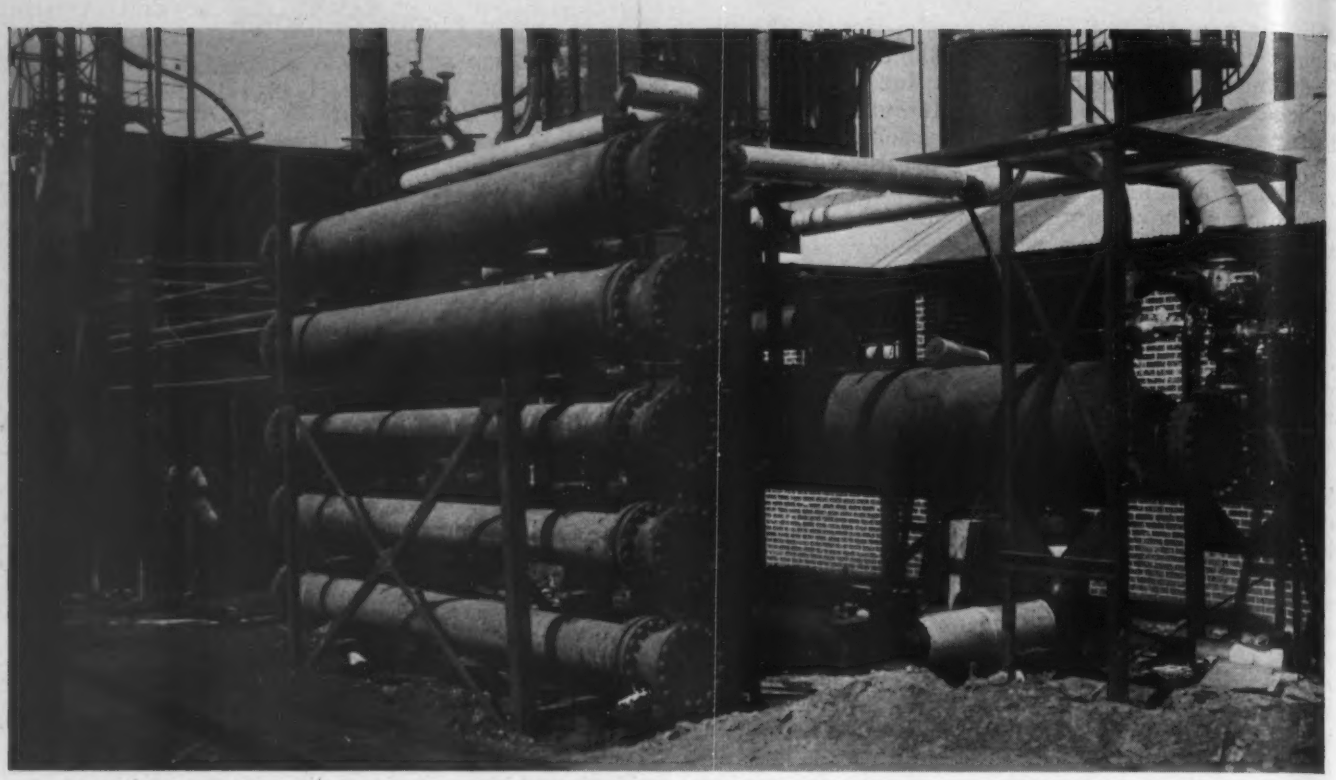


FIGURE 4

View of part of the stabilization equipment showing reboiler, after-cooler and heat exchangers.

from the ninth bubble tray of the main fractionating column.

It is also possible to take off a fraction from the twelfth or sixteenth bubble tray. This fraction can be used for fuel purposes or for a cut-back to decrease the viscosity of the residuum fuel.

In addition to the fractions mentioned, the tower also fractionates the charging stock to the furnaces into two distinct fractions; one being a heavy high-boiling charging stock which is taken off from the bottom of the bubble tower, the other being a light clean distillate charging stock which is taken from the twelfth tray of the bubble tower.

CONVENTIONAL CONDENSER COILS

After the unstabilized vapors leave the bubble tower they pass through the conventional type of condenser coils and into a reflux distillate accumulator. From there the unstabilized gasoline passes through the subcooler countercurrent to 60° F. water, and then into the distillate receiver. The unstabilized gasoline is then picked up by a 12 x 5 x 12 duplex pump which pumps it into the stabilization system.

The stabilization system contains a stabilizer column equipped with two charge-to-bottoms heat exchangers, shell-to-tube reboiler at bottom of tower and shell-to-tube condenser on top, and three shell-to-tube, water-to-gasoline after-coolers. The gasoline after leaving the pump passes through a heat exchanger countercurrent to the stabilized gasoline as it is leaving the plant. After passing through the heat exchanger it is discharged into about the middle of the stabilizing column.

The stabilizing column is 42 inches in diameter and 43 feet in height, containing 26 bubble trays and has three nozzles through which the feed may enter the column. The temperature of the base of the stabilization column is maintained by a shell-to-tube reboiler through which the gasoline passes countercurrent to a fraction of hot oil from the bubble tower. This hot oil maintains a temperature in the reboiler of about 320° F. and of 280° F. in the bottom of the stabilization tower. The temperature in the top of the column is controlled by a water condenser and can be held at a temper-

FIGURE 5

Interior view of pump house, showing the hot-oil pump and the Diesel engine, to the left.

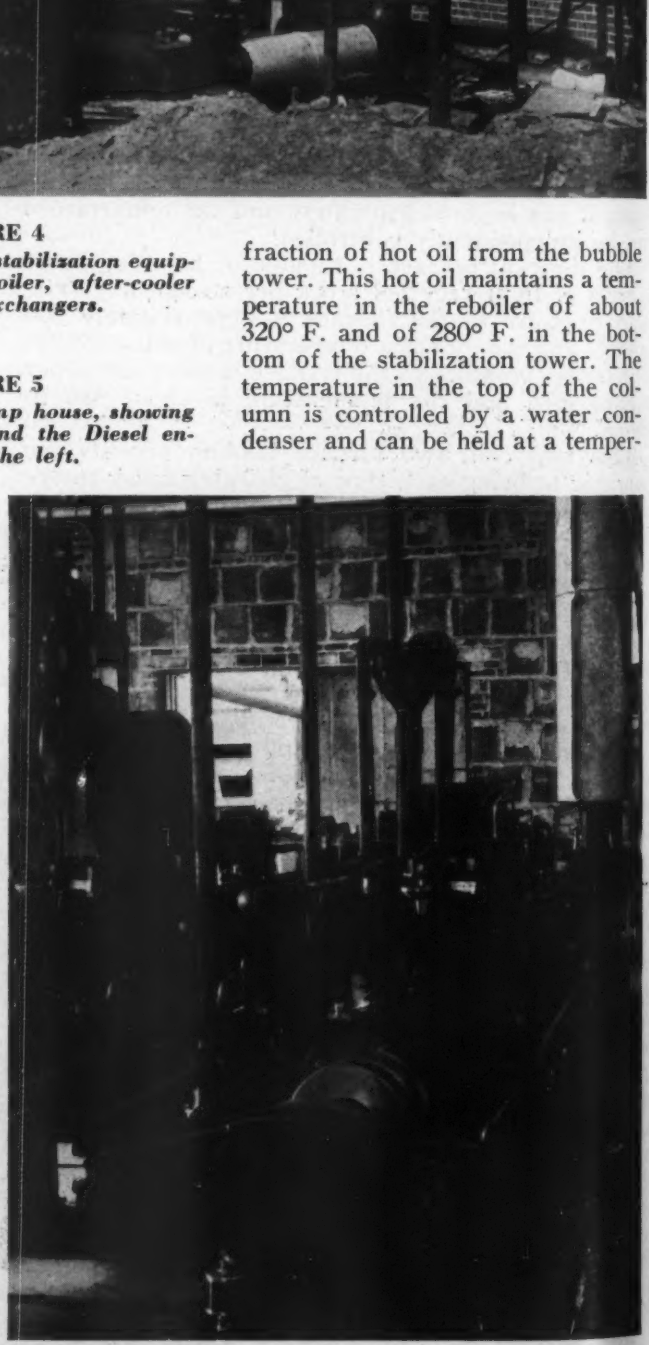


TABLE 1

Johnson Oil Refining Company, Cleveland, Ohio
Typical Analysis of Some of the Products Made on New Unit

	Gasolene from Dubbs Unit		Oil to Light Oil Furnace		Charging Stock to Dubbs Unit	Analysis of Residuum Fuel
Gravity....	59.4	59.3	24.5	24.4	27.0	Gravity—9.5 Be.
Reed Vapor Pressure..	9.6 lb	9.8 lb	....	....	....	Flash—275° F.
Octane No..	68	68				Fire—375° F.
Initial Boiling Point.	95° F.	95° F.	400° F.	400° F.	535° F.	Furol Vis. at 122 —120 sec.
10 percent..	132	136	460	455	569	Pour point—Below 25° F.
20 percent..	163	170	471	469	611	B.S. & W.—0.4 percent
30 percent..	197	205	482	480	642	
40 percent..	225	236	489	487	675	
50 percent..	253	266	495	496	692	
60 percent..	279	292	507	507	716	
70 percent..	305	314	522	520	743	
80 percent..	333	340	539	536	750	
90 percent..	368	368	556	557	764	
95 percent..	386	388	575	572	...	
End Point, percent...	397	396	604	599	784	
Recovery, percent...	97.0	96.5	98.0	98.0	94.5	

ature so that gasoline of any desired vapor pressure can be made. The unstabilized gasoline enters the middle of the stabilizer tower, getting warmer and warmer as it goes downward to the bottom, and then to the shell-to-tube reboiler where it reaches a temperature sufficient to drive off all undesirable light hydrocarbons. The stabilized gasoline then passes out through two heat exchangers countercurrent to the incoming gasoline and then, through three sections of a water-to-gasoline after-cooler, the gasoline flowing countercurrent to 60 degree water coming into the plant. From there the stabilized gasoline goes to the storage tank. After passing through the stabilization system the gasoline is free of ethane and propane and the butane percent is controlled according to the vapor pressure of the gasoline desired.

The gas vapors leaving the top of the stabilizing tower may still contain desirable gasoline fractions and they in turn are passed back through the absorption column where the desirable gasoline constituents are picked up. The stabilization system is capable of processing 65,000 gallons of gasoline per day.

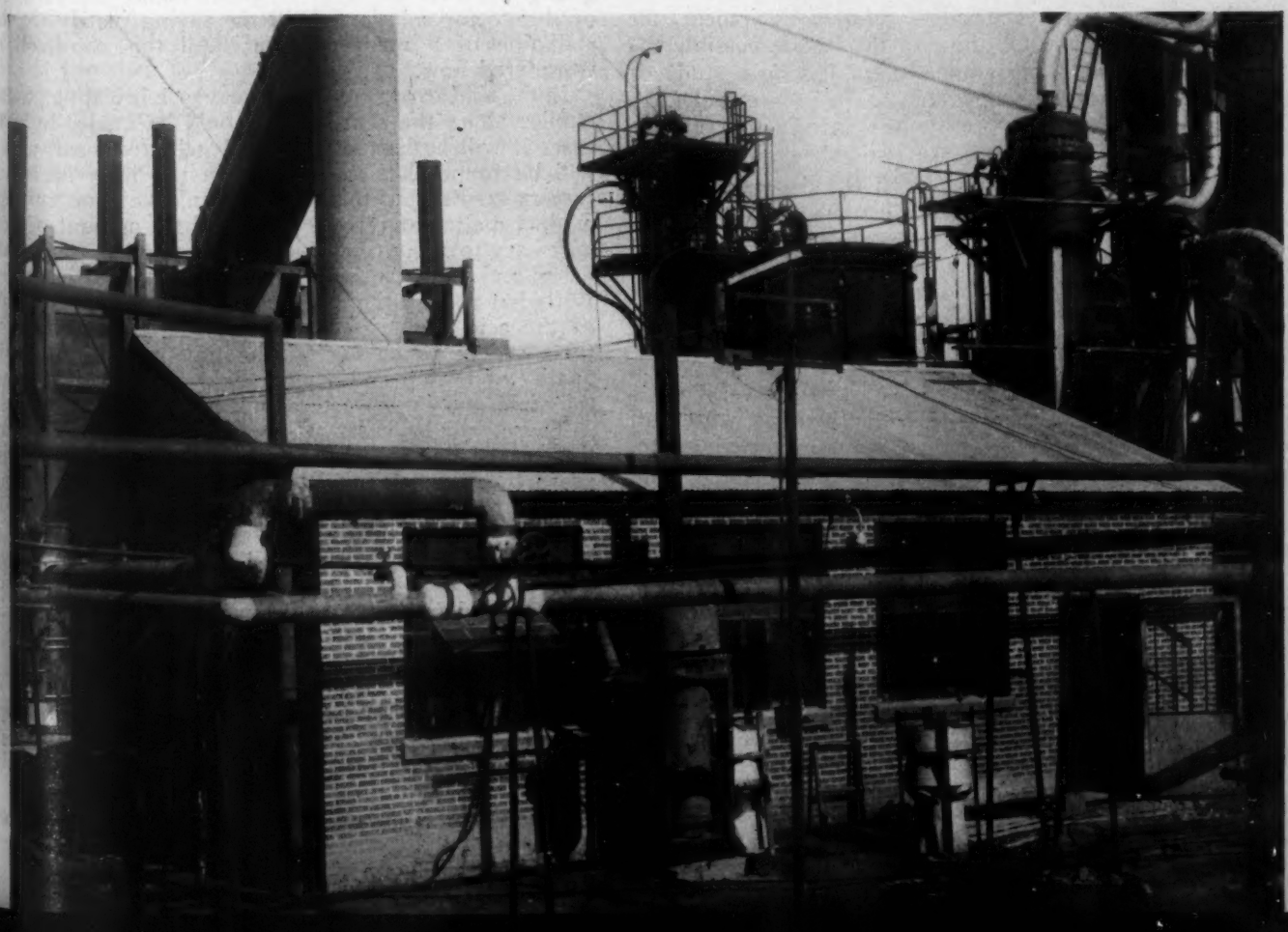
GASOLINE SPECIFICATIONS

Gasoline of any desired vapor pressure and distillation range can be made. End-point can also be varied to meet seasonal demands. The yield of gasoline can be varied between 50 percent to 60 percent, according to the distillation range and octane desired. In making the usual 400-end-point gasoline of 68/70 octane, yields of at least 55 percent can be obtained.

The new unit has all of the latest control instruments. Flow controllers, liquid-level controllers, pressure controllers, pressure recording, temperature indicating and recording instruments are used on the unit and are centrally located on the instrument board in the control house. This instrumentation allows a close correlation of the various parts of the unit and tends toward longer runs, smoothness of operation and better products.

The plant is operated under the Dubbs patents and the engineering was done under the supervision of Universal Oil Products Company. The construction work was all done by Johnson Oil Refining Company except the furnaces which were built under contract by Frick-Reid Supply Corporation. The stabilization equipment and the main fractionating tower were built by Tulsa Boiler and Machinery Company. Johnson Oil Refining Company has a plant that has flexibility of operation so that various types of products can be made, and soundness of equipment so that operating conditions can be varied to meet changing requirements.

FIGURE 6
View of one of the pump houses.



Taking Stock

L. C. TRESCOTT

IN THESE days industry is facing greater changes and greater problems than at any other time in its history. There is not only the debris from the hard years of the depression to be cleared away, but there must be new ideas, closer study and organization to meet the fast changing present and future. It is a good time to take stock, to check up on organization and equipment.

Most of the newer processes are still in the stage of almost constant test. Their efficiency can be checked at any time with little trouble. They have been going too short a time for much dead wood to collect. With the older operations that really form the ground work for refining, the condition is a little different. There have been all sorts of opportunity for deterioration both in equipment and organization. This in most cases is no less insidious because it has been slow. It is not always so easy to locate and remedy. It extends from the crude tank farm to the shipping shed, from the laborer in the ditch to the man at the top. And the first move toward a cure must be to face the situation squarely.

IN this discussion many points have been brought up which would not be covered in the usual line of study of plant efficiency. Many of these have come into notice as a result of a deterioration growing out of the slow times of the depression. And the fact that this deterioration has been slow, generally extending over a period of years is all the more reason why it should be dragged into the light and a real effort made to prevent it going further.

EQUIPMENT AND ORGANIZATION

The problem of general refinery efficiency divides itself two ways. One considers refinery equipment, the other organization. Of the two the last is possibly the most important at this time. In conducting a study of these it is not always possible to follow set rules. In digging out and interpreting the information all the experience and common sense available should be used.

Few plants have gone through the depression years without accumulating run-down equipment. In too many cases it was considered an economy to cut down on maintenance. Or equipment was allowed to lie idle when production was low and then was started on short notice without proper and complete overhauling. One of the purposes of efficiency studies should be the determination of the actual physical condition of all equipment. This study should go back for the past several years into the history of the equipment. When has it been off stream and on? When has it been inspected or repaired? This matter should be gone into with the operators of the apparatus. Often they can hand out real data that appears in no records.

One of the first points to be considered is the effect of corrosion. Whether it comes through use or disuse, it never stops. There is nothing new or startling in this statement. Everyone knows that metal will rust and scale off. Right—but there are an astonishing number of instances where nothing is done about it until a shut-down is actually forced.

To begin with the stills, answers must be found to the following:

What is the condition of the inside of a tower still? Have the trays corroded? Are they full of scale? Have any of them broken loose and dropped?

What is the condition of the boiling caps, the down pipes? Is the shell in a good and safe condition?

What about exchangers and condensers? Are they giving proper heat exchange? Should they be cleaned or retubed?

Is the fuel consumption what it should be? Are the furnaces and their tubes in good condition?

TREATING SYSTEMS

In that part of the investigation which covers the continuous treatment of naphthas and light oils a study should be made not only of the physical condition of the treating equipment but it should be determined whether or not the existing system is giving all the service that can be expected. In many plants these systems are not well designed, are something of a makeshift and as a result do not have the capacity or give the quality of treat of a more modern system. An investigation may show that an entirely new reagent will show improvement in both quality and costs.

What about doctor treatment? Is the method in use giving the best of results? What about the recovery of the doctor solution? Will the saving justify the installation of a recovery plant? All this can well be considered now.

In the acid treatment of the heavier lubricating stocks, studies along the same lines should be made. In most cases it will be best to stick to batch treatment, and it will be found that the method in use is giving satisfactory results, but this matter should be gone into and made a matter of record. Generally the amount of acid necessary to produce a given grade of oil is well established and there can be little or no change at that point. But what about agitating time? What about the fluidity of the acid sludge? This is a good time to check on these points. A change of the first may improve the quality of the oil and a more fluid sludge will increase the yield and improve the sludge-handling conditions.

There will be cases where the installation of continuous treating methods may merit consideration. Here again the increase in yield will prove the outstanding factor, provided the quantity of oil of one grade to be treated justifies the installation. Such a system may show a saving in acid as well as an increase in yield, and on the whole will show some drop in operating cost, particularly on very heavy oils.

DISPOSAL OF ACID SLUDGE

This is a good time to inquire into the disposal of acid sludge. In case such is not already the practice, can it not be burned as fuel?

In many existing acid-recovery plants there is also

room for improvement. Formerly it was considered good and satisfactory recovery if the cost of recovered acid were even higher than that of fresh acid. The important thing was to do something with the stuff at almost any cost. Many refineries would have preferred to run it into a stream or to use any means of disposal rather than be troubled with acid concentration, but today this view hardly holds good. An up-to-date recovery plant will turn out 66° acid at a lower figure than the cost of fresh acid and it may pay well to revamp existing oufits. In any event a survey should include a thorough investigation of this point. And for this particular job it would be well to bring in a man with actual experience with the more modern plants and methods.

REFRIGERATING EFFICIENCY

As the survey moves on to the wax plant it may be found that the refrigerating equipment needs a thorough overhauling. A determination should be made of the actual efficiency of this equipment as well as its physical condition. Chillers, especially, seem to show bad effects from being kept out of use. Even though they may operate well enough mechanically it will still be well to make a test on the efficiency of the heat interchange. In several recent instances it has been found necessary to rebuild chillers entirely due to a loss on this point.

In the filtration end of the plant the deterioration of equipment is probably less marked than in other departments. Filters, whether they be of the percolation type or the leaf type generally used in contact-treating plants are not subject to any great amount of corrosion or wear and tear.

In the contact-treating plant it is well to make a check on filter rates. This check can be made from plant records and may show that the filter leaves are plugged and that the clothes should be cleaned or renewed. It may also be found that the lowered rate is due to the centrifugal pumps feeding the filters. The rotors may be worn and should be replaced.

The lowered rate may also be due to a bad filter cake caused by water which has not been thoroughly removed in the foam tank or separator. Where this tank is provided with trays or an expanded metal packing it may be corroded to such an extent that the mixture is not spread out enough to allow the water to pass off.

An examination should also be made of all furnaces, tubes, exchangers, etc., in the contact treating plant.

CAPACITY

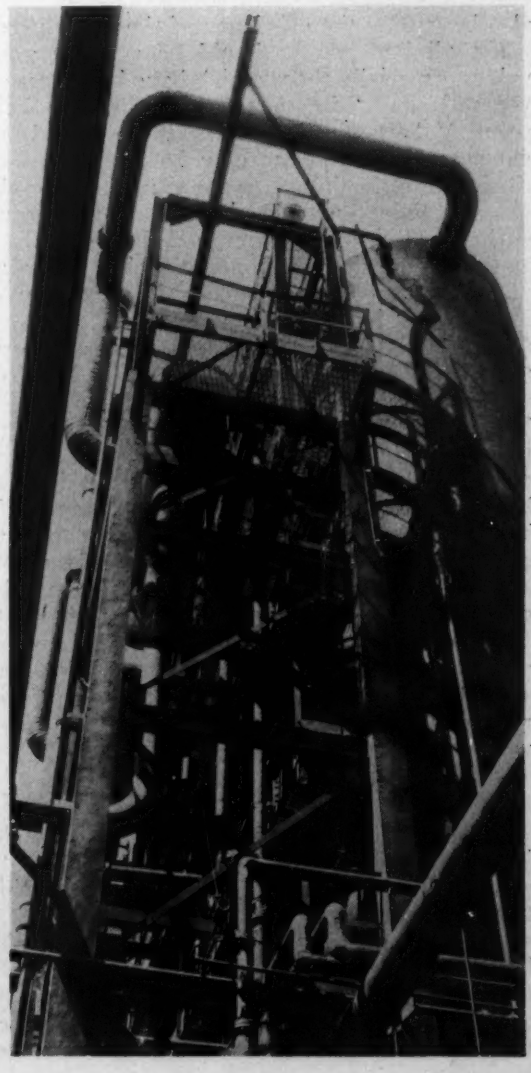
It is seldom possible to judge the efficiency of equipment in the petroleum industry from the base of its rated capacity or the capacity for which it was orginally designed. More often than not we find it operating under an increase of from 50 to 100 percent. Generally this overload has developed gradually. Very often the fact is not recognized that there is an overload. The survey should go into this matter thoroughly. If the equipment is being operated at a higher capacity than that for which it was designed, is the extra production gained at the expense of efficiency? Does it put too great a load on the equipment? On the other hand, once the real facts are known and put on record it may be possible to make a further increase in production. The layout should be gone over to determine whether or not some minor changes will not increase capacity. Can automatic control be used instead of manual control?

ADVANTAGES OF AUTOMATIC CONTROL

In considering automatic controls it must be taken into account that they are efficient not only as labor savers, but that they are very likely to give increased yields. It does not take much fluctuation to cut the yield of valuable products from 1 to 3 percent. No operator, however good his intentions or his attempts to do so, can hold operating conditions so nearly constant as can a properly designed controller. Even on jobs where it is necessary to have an operator on duty, the increase in yield due to constant control will more than pay for the installation of the special equipment.

In times past there has been plenty of reason for prejudice against automatic control. The instruments installed were more of a scientific nature than of a type to stand the wear and tear of plant use. The equipment itself was not of a type suited to anything but manual control and often required constant attention by a skilled operator. In these days, however, the combination of continuous processes and automatic control have been worked out on a thoroughly practical basis. Both refinery men and instrument designers have come to a better understanding of their problems with the result that not only are the instruments installed under conditions where they will give the best results, but they are designed to stand the gaff as well as any other plant equipment.

In the course of the survey the constant improvement in refinery equipment must be kept in mind. It is well to compare the results from existing installations with those that may be expected from more improved types. Possibly it may pay to scrap the former and in-



stall something new. Here again it must be kept in mind that even a small increase in yield may justify the expense of considerable equipment.

TRANSPORTATION LINES

The various units of the refinery are tied together by the transportation network and deficiencies here are reflected in general refinery efficiency. However, this element is likely to be the last to be scrutinized in an efficiency survey. The expansion of pipe lines more often takes the form of emergency work than it does of a well planned operation. There is usually little record kept of these changes and expansions. As a rule they are carried in the heads of the pumpers immediately interested and of any others to whom the information may happen to be passed. A survey should give a good opportunity to get as many of these as possible on paper. The best way to handle this will be in some sort of sketch form, based on the particular pumpings for which the lines are used. To attempt to put them on a large single map will only result in a maze of lines of no real use to anyone.

In this scrutiny there is a fair chance that while many obsolete and useless lines will be found, it will also be discovered that there are insufficient lines and connections between some of the major operations. It may be found that certain lines are used for several stocks which are pumped in large quantities and where much conflict is likely to occur. It may also be found that the pumps handling large quantities of stocks are far too small for present needs. Constrictions in suction and delivery lines or overly long suction lines may also be cutting the efficiency of the pumping equipment.

On all lines there should be a check made on the valves, especially those which have been in use for many years. Usually the men on the job can help on this point. Valves will be found with corroded and leaking gates and seats, stems may be bent so as to prevent closing or something may be caught under the gate. A close examination will show a surprising number of such cases. Not all of them are bad, few are so located as to cause serious contamination but all are sources of potential trouble, as a single bad failure may easily cost more than a hundred renewals.

Another thing which often creeps in gradually is the too-close connection of important lines, of lines in which not the slightest contamination is permissable. These may have been laid out in the beginning so as to absolutely do away with any danger but as time passed it has been convenient to put in a cross-over here and there. As a result it will often be found that important lines where even a slight contamination would cause considerable loss are separated by a single valve. Also this single valve may be so seldom used that most of the pumpers never even give it a thought.

In the older pump house many of the valves on the pumps and headers have been in use for years. These should be examined carefully and where there is any reason at all to suspect leakage they should be replaced with tested valves.

SHOULD HAVE SUFFICIENT TANKS

Another point which slows up jobs and causes a loss of efficiency is the lack of sufficient tankage to properly meet the needs of a department. Some of the trouble from this source may come from the use of insufficient foresight in handling the tanks. Work may be so mapped out that it ties things up unnecessarily. On the other hand there is likely to be an actual shortage. During the slow times there was little need for new tanks and though the need has greatly increased during the past year an effort has been made to get along with existing tankage. This has resulted in many tie-ups and with the continued increase in production in sight, sufficient tanks should be supplied to do away with makeshift operation.

The strategic location of tanks with proper heating coils for handling heavy oils should be given consideration. This is of special importance when deliveries must be made on short notice, as in bunkering ships, loading tank cars, etc. Such oils must be kept warm enough to pump easily and where the business justifies it the heated tanks should be located close to the loading pumps, and close to the loading point. This will save drawing on tanks some distance away with the resultant slowing down of the loading.

The condition of the refinery yard is important from other than just the aesthetic point of view. It affects general plant safety and fire risks and it lowers efficiency by making it just that much harder for men to do their work. A cutting down of the regular yard clean-up services results in plugged sewers and the areas inside the firebanks get covered with oily slime. Puddles of oil from breaks and spills collect in the runways. Few men enjoy puddling through this sort of mess and it adds an unpleasantness which hardly helps get the work done. In many cases lines are dug up and left without proper filling, and with it all the yard would disgrace a no-man's-land. At night the conditions are particularly bad as a man in a hurry will run into these messes in spite of every care. When sewers plug and the firebanks fill with water it is often necessary to wade in order to reach valves, or it may be necessary to climb out over slippery pipes. There is no economy in this sort of thing. A single accident can cost more than any clean-up expense, or the cost of providing proper walk-ways. The irritation and extra trouble of trying to work under such conditions hardly makes for efficiency. And keep in mind—the loss of efficiency and the danger from such causes naturally increases on night work and during bad weather.

SMALL TOOLS

In every department some special small tools, such as wrenches, valve hooks, electric lanterns, etc., are needed. The survey should go into this matter. Such tools are usually inexpensive and should be supplied in sufficient quantities to fit the needs of any department. Provision should also be made for the storage and issuance of such of these as are not in general use. The time spent in hunting and trying to fit makeshift tools will far more than cover the cost of supplying proper ones. Replacing a blown gasket, especially at night, is far from a pleasant easy job in any case and forcing a man to try the job with wrenches that fail to hold is only making it that much more difficult—at the company's expense.

Then there is the matter of lights. No survey can be complete that does not go into this thoroughly. Night work around a refinery is not the easiest thing in the world. It is especially bad in the winter or in bad weather. The permanent refinery lights should be sufficient and should be so placed as to be of real value. Plenty of portable lights or hand lanterns should be supplied and they should be kept in proper repair. Lights which are poor, which flick on and off when they are most needed are a danger as well as a nuisance. With such lights a man may walk right alongside of a break or a spill and never see it, or walk into a hole of scalding water. It should be recognized that good lights are a necessity and not a luxury. Poor ones are an expense and a drag on efficiency.

Efficient Sweetening System

Operates On Stabilizer Pressure

R. E. LEGE
Southport Petroleum Company

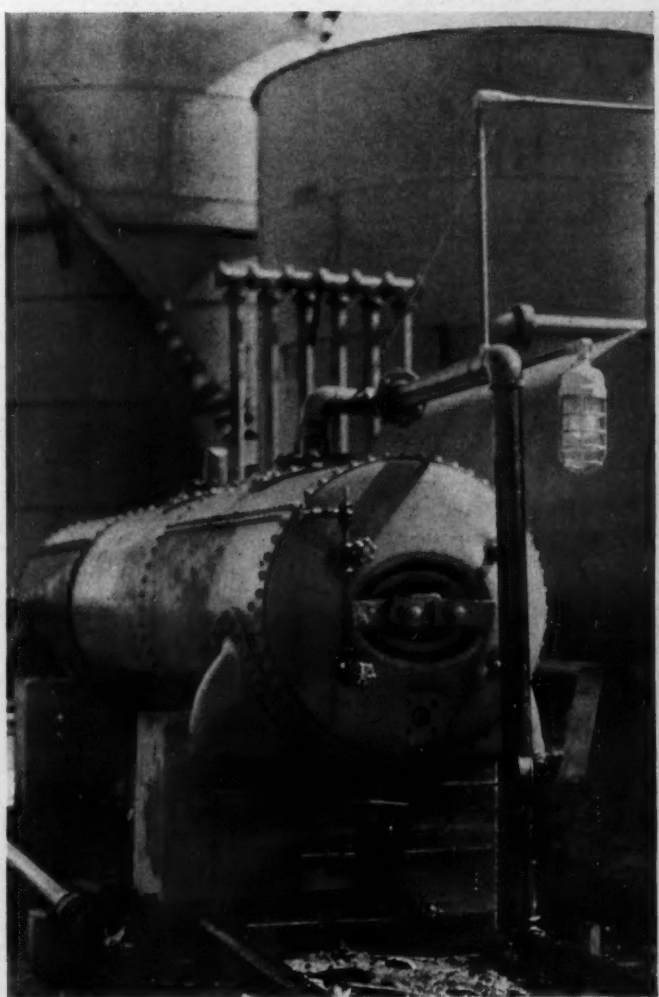
THE Doctor Sweetening plant at the Southport Petroleum Company's Texas City, Texas, refinery uses no pump to handle the untreated gasoline charged to the system, since the stabilizer pressure of 200 pounds per square inch is more than sufficient to move it to storage by way of the treating plant.

The treating plant consists of a caustic scrubber, pressure-control valve, a sulfur pot, mixers for contacting the doctor and gasoline, also the sulfur to effect a "break", a water-wash settler, and finally, a sodium-sulfite scrubber.

The untreated gasoline flows from the stabilizer to the caustic scrubber, a vessel 3x14 feet, set horizontally. Approximately 8 barrels of 15 degree caustic soda is carried in the scrubber. This is replaced when required. Contacting the gasoline with the caustic is accomplished in a novel manner. In the line from the stabilizer a jet valve is placed so that with a slight differential in pressure the caustic is brought into contact with the gasoline. By raising or lowering the differential pressure the contacting may be gentle or so violent that an emulsion will result. This jet valve is a home-made device, having a long tapered seat, the opening at the large end 1½ inches, and 1 inch at the smaller. It is 4 inches long. A plug that neatly fits this seat was turned out and welded onto an old steel valve stem. Using the bonnet and wheel that originally went with the stem plus a 3-inch tee, 2 flanges, and the welding torch, it was fabricated. This valve is located 1 foot below the scrubber bottom to insure a constant flow of caustic. An opening in the valve immediately behind the 1-inch opening of the tapered seat connected to the bottom of the scrubber causes the jetting action of the caustic. The mixture of gasoline and caustic is dumped into the scrubber 1½ feet from the bottom of the scrubber at the opposite end from where the hydrogen sulfide-free gasoline leaves the scrubber.

Passing from the caustic scrubber, there is found the pressure control valve and sulfur pot. It has been found that when not using a pressure-control valve there was too much fluctuation of pressure to accurately control the sulfur to effect a "break." At this point the upstream side of the pressure usually registers 50 pounds per square inch, and on the downstream side, 30 pounds per square inch. The stream of gasoline going through the sulfur pot is taken off on the upstream side of the pressure control valve so that it can be controlled accurately. A half-inch needle valve in the line to the sulfur pot suffices.

After passing through the pressure-control valve the gasoline is contacted with the doctor solution (sodium plumbite) in 15 4-inch pipes 10 feet long. These pipes are perpendicular, connected at the top



Untreated gasoline flows fromthe stabilizer directly to the caustic scrubber shown above. Using stabilizer pressure, no pumping is required.

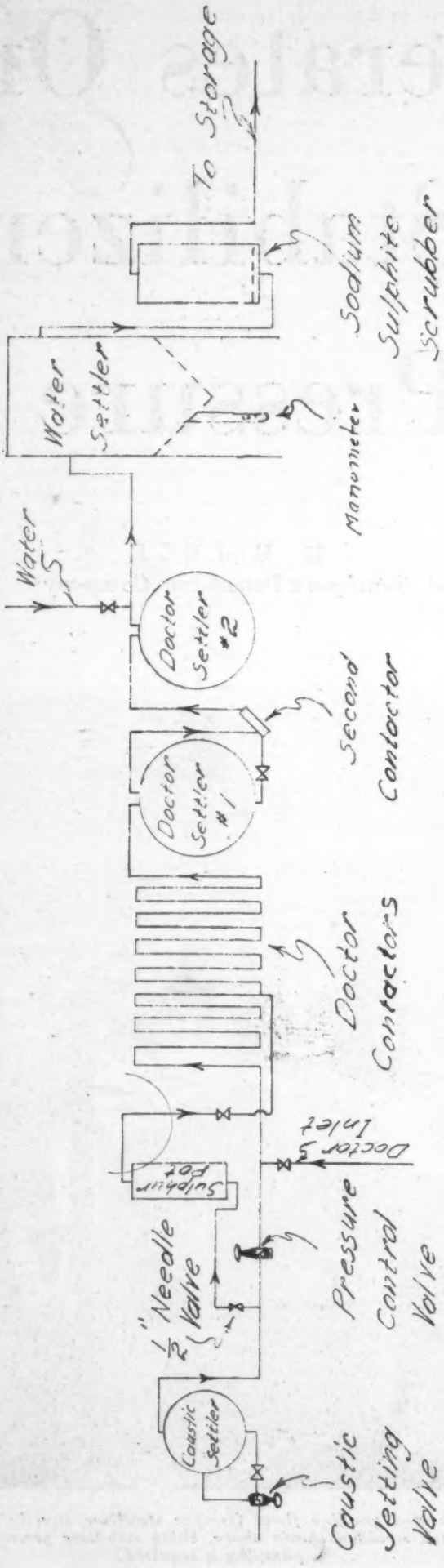


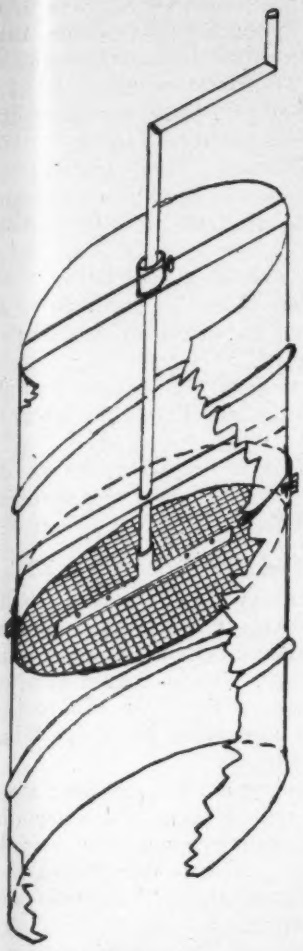
FIGURE 1

and bottom so that the doctor and gasoline flows up one and down the other. When the doctor and gasoline reach column number six in this contactor, the sulfuretted gasoline is admitted to "break" the gasoline. From number fifteen column the now "sweet" and "broken" gasoline flows to the first settler where the spent doctor and sulfides are drawn off to be reclaimed. From the first settler the gasoline flows to the second settler. In the line from the first settler to the second is another horizontal mixer with a connection to the bottom of the first, so that if the desired sweetening is not attained, a second contacting is given the gasoline. The second settler is also equipped with draw-offs to the reclaiming plant. These settlers are two 8000-gallon tank cars set horizontally.

The gasoline flows from the second settler to a water settler. The water washing is done in the flow line which is a 6-inch pipe with a 2-inch perforated line inside, the water being forced through the perforations violently, and washing the gasoline completely. The water settler is an old 600 barrel agitator with a gas-tight top, provided with a 2-inch vent line to relieve any pressure. A quantity of sulfides are washed out at this point, and by shutting off the water wash and drawing the water down to the sulfide layer in the agitator, they may be drawn to a 50-barrel tank and there pumped to the reclamation plant.

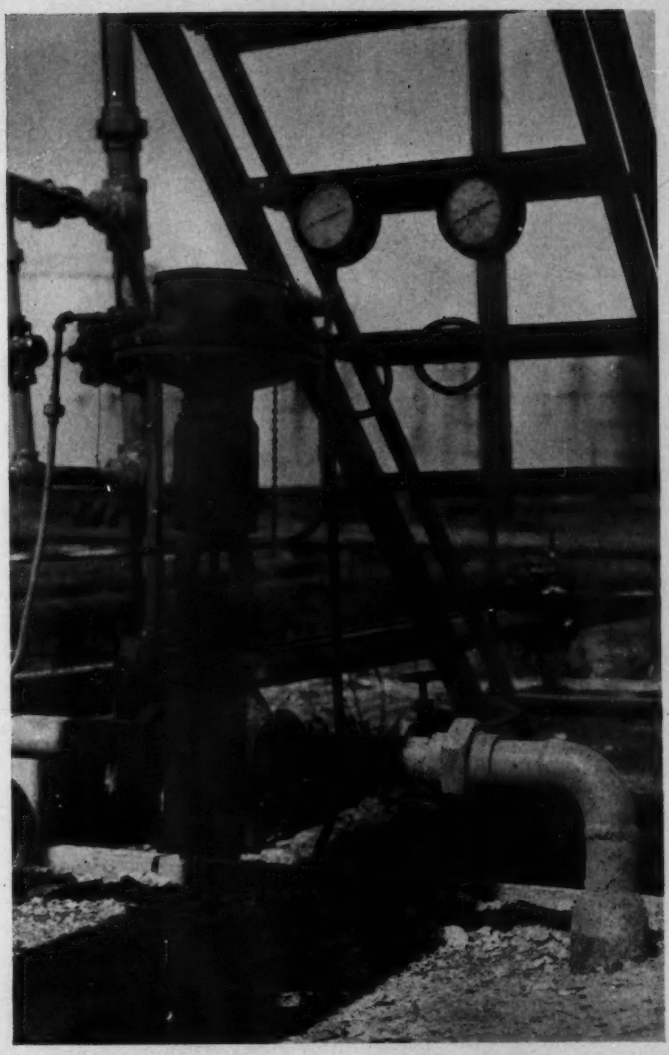
At the reclamation plant are three make-up tanks used for making up new doctor and fortifying the reclaimed doctor if and when needed. These tanks are 10x14x16 feet with a steel walkway connecting them. On top of each tank is a sifter on the same order as a regular flour sifter, made by using two litharge cans. The top of the bottom can was slightly swaged so the base of the top one would fit into it loosely. Four sets of lugs were welded on the cans so that they could be bolted together after a piece of screen wire was cut, one inch in diameter larger than the cans, and fitted between them. A piece of strap iron was welded across the top of the upper can, and another piece of strap iron was welded 4 inches from the bottom. A hole was bored in the center of each piece of strap iron to accommodate a ⅝-inch rod. On the bottom of this rod two paddles, reaching from the rod to the outside edge of the cans, were welded on. On the other end of the rod is a crank to turn the paddles around. On each of the paddles 2 pieces of old rubber belting were bolted to prevent wearing the screen. Near the top of the rod and just beneath the crank is a set-screw collar for adjusting the height of the paddles so that they will barely touch the screen. The sifter will not handle large quantities of litharge at a time but 25 pounds can be sifted through in about one minute. Taking into consideration that there is no loss caused by lumps, and that the material goes into solution immediately, this is not a great disadvantage. When adding litharge with a shovel, or in similar manner, a great deal goes to the bottom of the tanks in the form of lumps and stays there. The sifter is placed as near the surface of the doctor as possible to prevent the wind from blowing any of the litharge out of the tank.

A mercury monometer has proven invaluable in indicating water level in the water settler. Since it is a cone-bottomed vessel, gauge glasses would have proven difficult to install, to say nothing of their plugging up with sulfides. This monometer is se-



THE MIXER

The pressure control valve eliminates fluctuation and assures accuracy of sweetening. The stream of gasoline going through the sulfur put is taken off on the upstream side of the control valve.



Water circulating pump in the foreground (below), doctor circulating pump and stand-by next with sulfur pot in background.

The jet valve is placed in the line from the stabilizer to the caustic scrubber and a slight differential in pressure assures intimate contact between caustic and gasoline.

cured at the bottom of the settler at a height near the level of the eye with one side connected to the settler 1 foot above the apex of the cone bottom. Theo ther side of the monometer is connected 5 feet from the top of the settler. Quarter-inch pipe is used for both monometer connections. The operator, by merely glancing at the monometer knows exactly where his water level is as the slightest difference is shown on the scale. However there is a ½-inch connection near the top of the cone bottom for use in case of the monometer failing. So far the monometer has not failed to perform its duty.

The sweetened gasoline from the water settler passes now to the sodium sulfite scrubber, entering at the bottom and flowing out at the top. This scrubber is a vessel 4x14 feet set perpendicularly with a perforated plate located 1 foot off the bottom to act as a baffle, insuring intimate contact. Approximately 4 feet of 2 percent sodium sulfite solution is carried in the bottom. From the sodium sulfite tower the gasoline, now a finished product, bright, no water or sulfides in suspension, flows to storage, ready for immediate consumption.

SUMMARY

This treating plant has been found advantageous for the following reasons:

1. That no pump is used to handle the gasoline from the stabilizers to the finished storage, thus eliminating run-down tanks and attendant piping.

2. As the gasoline is treated at the rate of 90 to 105 barrels per hour only just the exact quantity of chemicals that are actually required to sweeten are used. Also that this rate of throughput allows ample time for settling both in the doctor settlers and the water-wash settler. That the product when it leaves the sodium-sulfite scrubber is ready for immediate shipment, which is a great saving of time.

3. Savings effected in power, losses greatly minimized by treating in a closed system, more than pay for the extra help required to operate 24 hours per day.

4. That the plant is very flexible, being under perfect control at all times. Rates of from 50 to 150 barrels per hour have been experienced, causing the operators no great difficulty.

Flexible, also, in that at least 12 different crudes have been run here causing no difficulty whatever in the treating.

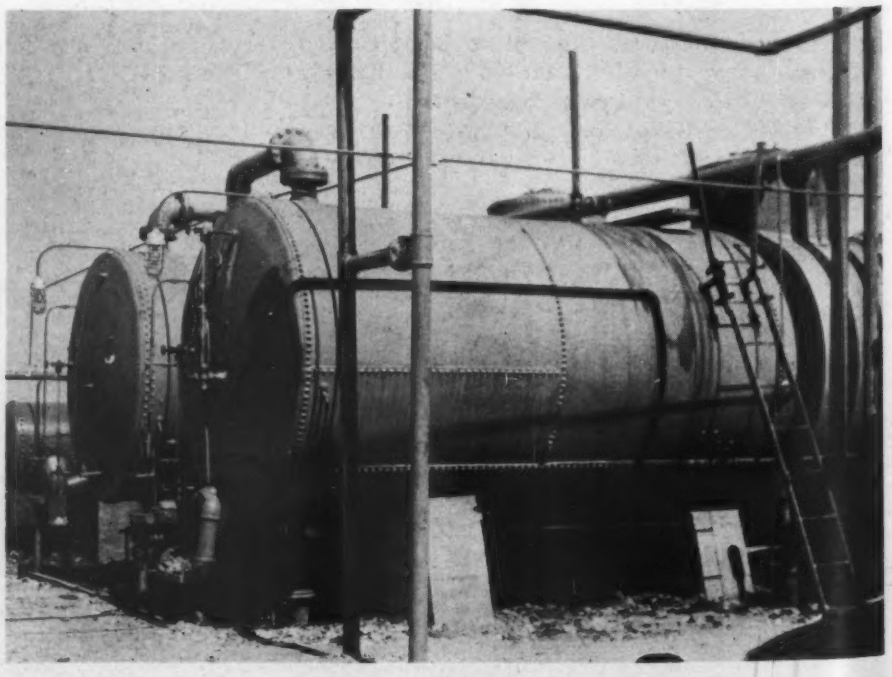
5. That an average of only eight-tenths of one point of octane or less is lost between the stabilizer and the storage tanks, which is considered normal.

DESCRIPTION OF EQUIPMENT, PIPING, ETC.

The line from the stabilizer to the caustic scrubber, caustic scrubber to doctor contactors, excepting two 2-inch nipples used in connecting the pressure-control valve, is 3-inch pipe. The doctor contactors are of 4-inch pipe. The rest of the flow piping is 6-inch. All doctor draw-offs and inlet lines are 2-inch pipe.

One centrifugal pump using a 2-horsepower motor handles the doctor into the system. Another centrifugal pump using a 5-horsepower motor does the pumping of the water. The pressure-control valve is an air-operated 2-inch control. Lubricated plug valves are used throughout the system.

The sulfur pot is a piece of 16-inch pipe 10 feet long with the bottom end closed, the top has a 6-inch flanged opening for filling with sulfur. Two 2-inch openings, one at the top and one at the bottom, are used as an inlet and an outlet for the sulfuretted gasoline. The sulfur pot is set perpendicularly and has a steel stairway to facilitate filling.



Caustic settlers are two former tank cars of 8,000 gallons capacity. Two of the vertical contactors are shown at the right.

Corrosion in Cracking Units

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SERIOUS corrosion occurs in cracking stills. It may be found at any point in the equipment. The amount and character of the corrosion experienced is dependent on many factors, including impurities in the oil, temperatures attained during operation, velocities, materials of construction, and many others.

Corrosion-resistant materials and protective linings are being used where corrosion is severe and they are economically justified. In order to keep the equipment safe, it is necessary to make systematic periodic inspections so that the amount of sound material remaining is known and replacements can be made or protective measures can be taken when necessary.

WHEN corrosive oils are handled, all types of corrosion may be encountered, and it may be found at any point. In some cases, it is plainly apparent that corrosion is occurring, as evidenced by pitting, grooving or similar effects. Much more frequently, however, the results of corrosion are not so plainly apparent. Frequently, the corroded surface is as smooth as the original surface. Also, the rate of corrosion may vary considerably from time to time with changes in character of the feed stock or with changes in the operating conditions. As a result, careful, systematic inspection is necessary to determine the amount of corrosion which has occurred.

In discussing corrosion in cracking units, one must consider the kind of crude from which the feed stock was cut. Many of the statements made in this discussion are based on experience with West Texas and other highly corrosive crudes.

CAUSES OF CORROSION

A considerable proportion of the oil refined today contains various sulphur compounds, including hydrogen sulphide. Many of the sulphur compounds are unstable at the temperatures encountered and break down into their component parts. The free sulphur thus released unites with hydrogen from the oil and forms hydrogen sulphide. Some of the chemical reactions occurring and some of the compounds formed may be corrosive. Also, hydrogen sulphide in the presence of moisture is corrosive. The oil with the highest sulphur content is not necessarily the most corrosive for this is dependent, to some extent, on the character of the sulphur compounds present. However, an oil with appreciable sulphur content will cause sufficient corrosion to require careful periodic inspection. Also, the corrosion caused by sulphur compounds accounts for the greater part of the losses found in cracking equipment.

Some oils contain salts with a chlorine base. These salts may break down and the chlorine unite with hydrogen to form hydrochloric acid. Wherever condensation occurs, this will cause typical acid corrosion as evidenced by pitting.

Other corrosion may be caused by the water used for cooling and condensing. At seaboard plants, where salt water is used, this may be a serious factor.

The rate of corrosion is dependent on so many factors that it can only be determined by experience. It may, and generally does, vary considerably between different parts of the equipment. In general, the parts subjected to oil at the higher temperatures will corrode at the greatest rate. Also, where high velocity accompanies high oil temperatures, excessive rates of corrosion may be expected. On the other hand, where the surfaces may become heavily coated with coke, the corrosion rate may be less severe than anticipated. This is probably due to the fact that the coke prevents free circulation of the oil and its corrosive contents over the metal surface for at least a portion of the run. However, coke deposits cannot be depended on to prevent corrosion.

Where salts are present and hydrocholoric acid may be formed, severe and rapid corrosion may be found in the colder parts of the equipment due to condensation of the hydrochloric acid on the metal surfaces.

In a cracking unit, handling high sulphur stocks, the corrosion will probably start at a point where the oil reaches a temperature somewhat in excess of 500°F. As the temperature increases, the rate of corrosion will increase. Generally, it does not become excessive until a temperature of 700°F. or over is reached. Thus, the feed side of oil exchangers and the preheater tubes of the furnaces generally suffer only nominal corrosion. The radiant and soaker tubes, transfer lines, reaction chamber, release line and separator will probably suffer very severe corrosion. In many cases, part of the bubble tower will also suffer quite severe corrosion. Where both a primary and secondary bubble tower are used, severe corrosion may carry well through the primary tower. While the oil is reducing in temperature, quite severe corrosion may be experienced down to nearly 500°F. and nominal corrosion down to 350°F. It should be noted that, after the oil has been raised to a high temperature, it is more corrosive at lower temperatures than is the case during the heating period. This is probably explained by the change in character of the sulphur compounds which occurred at high temperature.

Another factor appearing to affect the rate of corrosion is the amount of protection used against cor-

rosion in the higher-temperature parts of the equipment. Where corrosion-resistant tubes and lines are used, and the reaction chambers are protected against corrosion, it appears that the rate of corrosion in the separator and bubble tower is increased. The further the protection is carried, the greater becomes the corrosion rate in the lower temperature equipment until the oil reaches some temperature at which it is no longer corrosive.

PROTECTION AGAINST CORROSION

There are three general methods of protecting against corrosion, namely:

1. Use of corrosion-resistant material.
2. Lining with some material which will prevent the oil from reaching the surface of the vessel.
3. Coating the surface of the metal with another corrosion-resistant metal.

Use of Corrosion Resistant Material. Parts composed entirely of corrosion-resistant material are usually those which cannot be lined or coated. These generally consist of tubes, headers or return bends (or those parts of them exposed to the oil), piping and valve trim. The two most common metals used are KA_2S and 4 to 6 percent chromium-molybdenum steel. The KA_2S is an 18 percent chromium, 8 percent nickel steel having a carbon content of less than .07 percent. It is practically totally resistant to attack by any of the highly-corrosive oils handled today. The 4 to 6 percent chromium-molybdenum steel contains 4 to 6 percent chromium and approximately ½ percent of molybdenum to reduce the tendency towards air hardening. In some cases, 1 percent of tungsten is used in place of the molybdenum. This steel is more resistant to corrosion than carbon steel but is not totally resistant. The corrosion rate may be anywhere from 1/15 to 1/3 that of carbon steel, dependent on the character of the oil and the conditions of operation. Generally, it appears that this material is less corrosion resistant to the more corrosive oils.

There are other corrosion-resistant alloys suitable for linings which are not suitable for use in making entire parts, due to their tendency to lose ductility and thereby lose their ability to withstand shock.

LINING

Many different linings are in use today affording more or less protection.

Steel vessels may now be obtained with corrosion-resistant-alloy linings which are an integral part of the sheet or which are welded to them by electric-resistance welding at very close intervals. The alloy used may be any of the corrosion-resistant alloys but preferably should be one having a coefficient of expansion close to that of the carbon-steel shell. Both of the above linings are formed with the sheet, the welded lining being installed while the sheet is flat. A new vessel of this type construction appears to have the best obtainable protection known today.

Existing vessels may be lined with corrosion-resistant alloy sheets installed in place. These sheets are usually cut narrow enough to pass through the largest existing opening and are plug welded to the shell at frequent intervals and edge welded to exclude oil, using an alloy welding rod and electric-arc welding. These appear to be very effective in preventing corrosion and should require little maintenance, if properly installed with good, sound welding.

Reinforced gunite, castic, asbestos mud and similar linings are also used with varying degrees of success. They require more or less frequent maintenance and periodic replacement. The life of such a liner may vary from six months to two or three years, depending on the degree of maintenance and severity of operating conditions. They do not give complete protection since, at times, portions of them break out and expose the metal until repaired. They do retard the corrosion and, under not too severe conditions, are quite successful.

Pipe fittings and valve bodies may be lined with corrosion-resistant alloys.

COATING

Metal-spray coating is also used for preventing corrosion. Most metals can be sprayed but aluminum seems to be the most commonly used. Such coatings will give complete protection as long as they remain intact. They require more or less maintenance and patching. There will be some losses with such coatings where the vessel wall is exposed between failure and the time recoating is done.

In addition, caustic and ammonia have been injected into various parts of the units to partially neutralize the corrosive agents. Generally, this has caused other complications not desirable. At best, it can only reduce the rate of corrosion.

INSPECTION

Since corrosion is known to occur at varying rates with different oils, different conditions of operation and in different parts of the equipment, it is essential to inspect all parts of a cracking unit to determine its condition and to assure that it is safe for further operation. The attitude of the inspector should always be that he may find corrosion anywhere until he has assured himself that there is none. Whenever any change is made in the operation of a piece of equipment, whether it is a change in pressure, temperature, character of the contents, substitution of a corrosion-resistant material for one which was formerly badly attacked, or any other change, the inspector must again take the attitude that corrosion may be found at any point where previously it had not been experienced.

Some of the points where most serious corrosion is to be expected are as follows:

In vessels containing corrosive liquids, the most serious corrosion is frequently at the liquid level. However, sufficient investigation of the remainder of the equipment must be made to determine if this is the case.

In vessels through which vapor or gases flow, the most serious corrosion is frequently experienced in the vicinity of the inlet.

In piping through which fluids are flowing, it is generally safe to assume that the higher the velocity, the greater will be the corrosion. Also, at points where turbulence occurs, the corrosion will probably exceed that found at other points.

Gate valves frequently are found to be seriously affected in the body between seats and particularly so, if they are used for throttling purposes.

There are many different ways of determining when corrosion has occurred and the extent of same. However, methods applicable to one kind of equipment or material may not be applicable to another kind. Each inspector has to use his own judgment

as to the method or combination of methods necessary for any particular piece of equipment.

VISUAL

In general, everything should be given as thorough a visual inspection as possible. Where possible, the equipment should be entered and where this is not possible, the best visual observation feasible from the outside should be made. During such examination careful note should be made of any pitting, grooving, cracking, checking, scaling, bulging or other irregularities, or doubtful conditions. Points where defects or doubtful conditions are found should be further investigated by other methods to determine the amount of sound metal remaining. In the case of lined or coated parts, particular care should be taken to see that the lining or coating is in good condition and is protecting the metal beneath it.

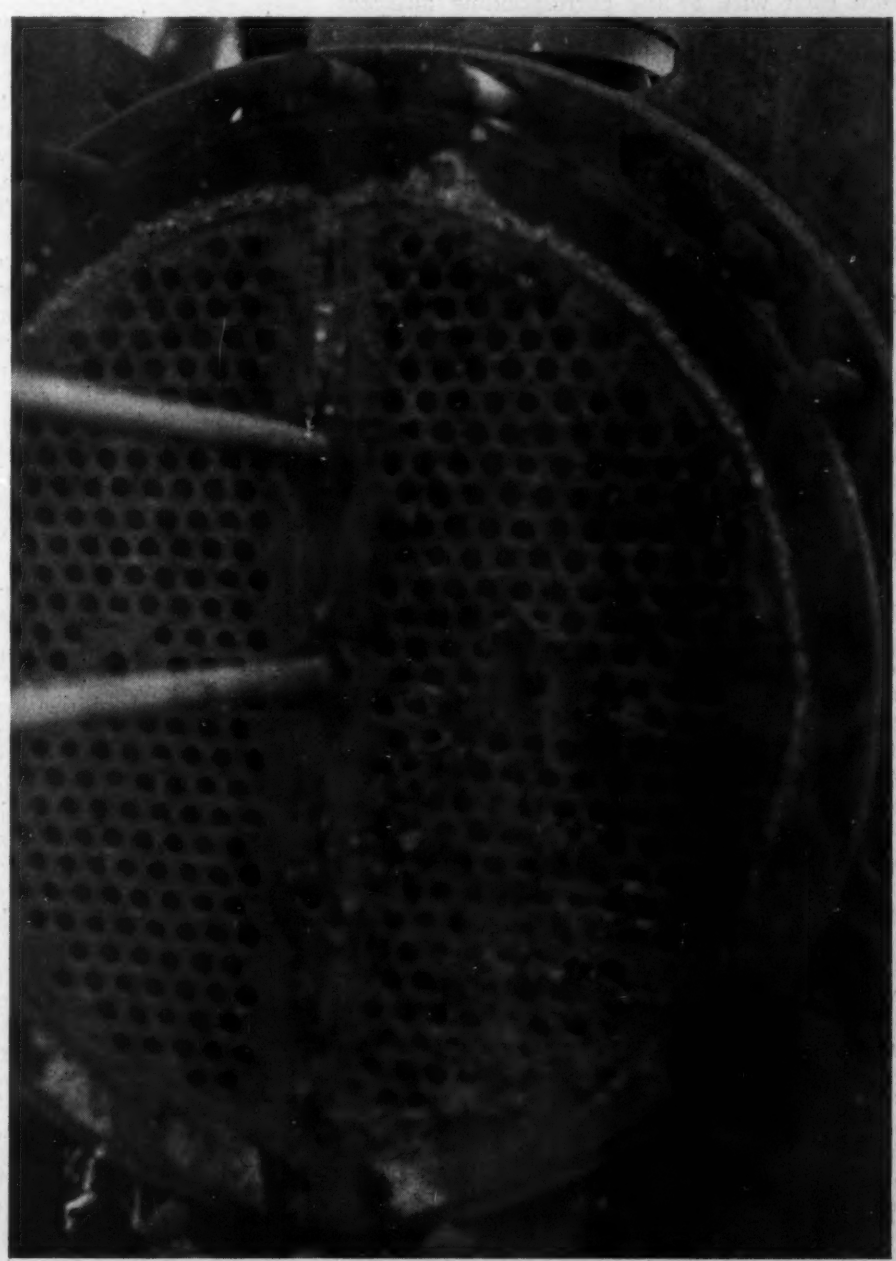
During the internal inspection of towers and drums, and similar equipment, all interior equipment should be carefully examined. Particular attention should be given to the supports of piping coils, trays, pans and so forth, to see that they are adequate to carry the load. In riveted vessels the heads of all rivets should be examined for corrosion, undercutting or other deterioration, since their condition gives a quick and reliable indication of the location of the most severe corrosion. The condition of all attached piping, nozzles, manheads, etc. should be observed from the interior of the vessel.

An exterior examination should be made for any unusual conditions. All attachments to vessels should be observed and particular attention given the supporting members to see that they are in condition to carry the load.

Sounding with a hammer to determine thin areas, loose rivets, etc. should be employed when applicable.

THICKNESS DETERMINATIONS

Several different methods may be employed for determining the remaining metal thickness after corrosion. In the case of vessels, this will depend on the thickness of the vessel wall and its position. For determining the thickness of a vessel from 3/16 to 2 or 2½ inches thick, it is usually feasible to drill small holes at the point one desires to investigate and later tap



Exchanger head corroded in refinery service.

these holes with a pipe or tapered tap and plug them so they can be used during future inspections. In some cases, it may be advisable to permanently plug such holes by welding or other means and drill new holes at subsequent inspections.

When the thickness of metal in a vessel is definitely known and it is not desirable or feasible to drill holes for determining future thicknesses, the depth of corrosion may be determined by establishing protected surfaces at predetermined points on the inside of the vessel. This can be done by welding on corrosion-resistant strips or buttons and later removing this protection and measuring the depth of corrosion from the protected surfaces under them. Another method is to drill small holes on the inside of the vessel at suitable places to a predetermined depth. Plugging these holes with a protective material prevents corrosion at the bottom. Loss in depth of the holes represents the loss in metal thickness by corrosion.

When it is necessary to determine the wall thickness of vessels and it is not feasible or desirable to drill completely through the wall, two taut parallel wires, one inside and one outside the drum, may be used. The metal thickness is then obtained by measuring the distance from each wire to the corresponding adjacent surface of the vessel wall and deducting the sum of these readings from the distance between the wires.

In some cases, wall thickness of vessels may be estimated by measuring the inside diameter with inside micrometer calipers. In such case, the wall thickness must necessarily be figured as one half the difference between the inside and outside diameters. The outside diameter is usually known but if not, it must be determined. Since some of the corrosion found in petroleum vessels is not uniform, this method may result in considerable error and should not be used if the thickness can be determined by any other method, and in any case, should be used only with discretion.

To determine the thickness of tubes in the furnace, it is obviously impossible to make an accurate check of the wall thickness for the full length of the tube, due to its length. Therefore, approximations of the tube wall thickness have to be made from inside and outside diameters. Where little corrosion is experienced, it may be sufficient to take inside diameters with a pair of long calipers, reaching into the tube as far as possible. Where severe corrosion is experienced, this is usually not sufficient because the corrosion may not be uniform and may be much more severe in the center of the tubes than at the end. In such cases, it becomes necessary to use a special tube micrometer with which measurements can be taken to the middle of the tube from either end.

External measurement of tubes is necessary only at points where bulging or eccentricity is noted, since the outside diameter tolerance of the tube is less than the error of internal diameter measurement or the error resulting from assuming the wall thickness to be one half the difference of the diameter. Such outside diameters as are required can be readily taken with ordinary outside calipers.

The wall thickness of header boxes or return bends joining the tubes can usually be measured by indicating or transfer calipers, using specially shaped legs on the calipers.

The wall thickness of pipe near the ends, and of valves and fittings can be determined by the use of either transfer or indicating calipers. In fittings, particular attention should be given to the wall thickness at points where change in direction of flow takes place. Straight lengths of pipe may have the internal diameter measured by means of a tube micrometer when general corrosion or bulging is suspected or indicated by other examinations. Frequently, hammer-testing of pipe is used for estimating the thickness. This should not be confused with sounding, which is used to detect thinner areas by change in tone. In hammer-testing pipe, a sufficiently heavy hammer must be used and a sufficiently strong blow must be struck to actually cause an indentation of the pipe wall if it is below the minimum allowable thickness. This test calls for considerable skill on the part of the inspector, since each different limiting thickness requires a blow of different intensity. Only practice and experience can teach an inspector how to use this method. On the other hand, an inspector really experienced in this method of determining thickness will come surprisingly close in judging the exact intensity of blow required to determine a given thickness. It is a method which every inspector should acquire since it can almost always be employed when no other method of determining the wall thickness of pipe is feasible. This method should never be employed while the pipe is in service or contains any flammable liquid or gas.

SAFETY DRILLING

As a supplement to wall thickness determinations, safety drilling may be employed. This consists of drilling small holes (3/32- or ⅛-inch) in the outer wall of pipe, fittings or vessels to a depth just equal to the minimum allowable thickness. The drill used for this purpose should be sharply pointed so that when corrosion occurs to the bottom of these holes the first leakage will be very slight. These holes should be spaced closely enough to give a fair idea of the condition of the entire part and particularly at points where experience has indicated the worst corrosion occurs. When leakage occurs through one of these holes, it is known that corrosion has occurred to a point where the metal remaining is the minimum for safe operation. This method is particularly applicable to pipe bends, flared type nozzles, large piping where joints cannot be readily opened for internal inspection, piping in inaccessible locations, and vessels which cannot be entered for observation. One method of safety drilling, outlined in detail the spacing of holes, etc. is covered by a U. S. patent.

DETECTION OF GRAPHITIZATION IN CAST IRON

Under certain conditions, the iron content of cast iron will leech out, leaving the graphitic content intact. This is known as graphitization. The wall of the casting will remain its original thickness, unless there is erosion, and the appearance of the material will not change other than to appear slightly darker. However, since the surface of a casting is usually discolored or coated by foreign substances, visual examination will not generally reveal this condition. Since this graphitic material has practically no strength, it is important to determine the depth to which such deterioration has progressed. This material can be cut or scraped about as easily as the lead in a hard lead pencil. Therefore, scraping the surface of an iron casting with a pointed or sharpened instrument, applying a fair amount of pressure during the scraping, will reveal this condition. If graphitization is indicated, it should be removed in spots until sound metal is reached. The entire wall thickness can be graphitized and not be detected by visual examination. The condition may be caused by external conditions or by the material carried in the casting. Therefore, iron castings should be examined, both internally and externally, for this condition.

Ceresin from Coke

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Dresden
Translated from PETROLEUM

CERESIN is actually obtained from coke. Of course, ceresin is not present in coke as such, which is impossible since coke has passed through temperatures close to 1000° C., at which all organic substances are decomposed. There are some types of coke which contain waxy substances, and even in fairly appreciable quantities. For instance, appreciable amounts of partially cracked ozokerite-type of waxes can be extracted together with the so-called lignite-tar oils from still-coke as obtained in the lignite-tar industry. But this coke, derived from the dry distillation of residues obtained in lignite-tar distillation has been only subjected to a temperature of some 300-400° C., and the waxy material is only found intact in the very center of the coke bed. At the edges and on the outside of the coke lumps, where the residue has been in contact directly with the red-hot iron of the still, one finds only traces of it, and it has been well cracked, and severely altered in composition.

Contrary to this type of wax, which is quite decomposed, we shall deal with ceresin as it is being technically derived from hard coke obtained from the coking of true coal tar. Other types of coke, or those of other origin can, of course, be utilized equally well. Appreciable marketable quantities of this wax have not yet found their way into commerce, since production has only been recently started. The process shortly will assume an important role. In this new and novel production of ceresin we deal with a synthesis in which the coke furnishes the carbon for building up compounds of carbon and hydrogen—the hydrocarbons. The manufacture of this ceresin was at first not contemplated, and it is purely a derivative or one of the by-products of the well-known benzine synthesis of Fischer and Tropsch, (*See Petroleum XXXII,* No. 31, p. 14 ff, 1936). No doubt many lay readers as well as technologists are familar with this process. For this reason only a general description will now be indicated.

The coke is gasified, and converted into water-gas—a mixture of carbon monoxide and hydrogen. It is carried out by blowing the coke in generators with preheated air at very high temperatures until the coke has become white-hot. This conversion of coke by air or oxygen is decidedly exothermic, as is well known to fuel and combustion engineers. As soon as the coke has reached this high temperature in the generators, live steam is blown through the coke bed; the former is decomposed by the coke according to the following reaction:

$$C + H_2O \rightarrow CO + H_2$$

This reaction absorbs heat, and the coke in the generators gradually cools down. As soon as the live steam no longer accomplishes decomposition at a lively rate, super-heated air is again blown through the coke bed, in order to bring the latter to redness, and the cycle is again repeated. There are of course several variations in the procedure; one can here merely indicate that efforts are being made to work this process continuously, namely by adding oxygen during the blowing with steam, and again by heating certain easily oxidizable types of coke outside of the generators. Such procedures are not as yet quite successful, but nevertheless, appear highly promising.

Part of the hydrogen can also be secured from coke-oven gases, which are rich in hydrogen, and which can be readily used as an addition wherever this type of crude gas is available. The mixture of carbon monoxide and hydrogen, or the same mixture enriched further with hydrogen, the so-called "synthesis-gas," is next led over special catalysts, at about 200° C., and synthetic hydrocarbons and water vapor are formed according to the following equation:

$$x\,CO + 2x\,H_2 \rightarrow (CH_2)x + x\,H_2O$$

The hydrocarbons are very diverse in character, and they are produced as a mixture of gaseous, liquid and solid products.

The practical controlling factors in this synthesis to obtain the many types of hydrocarbons is shown in tabular form below:

EFFECT OF VARIOUS CONDITIONS ON THE TYPE OF SYNTHETIC PRODUCTS

1. Increasing pressure: Synthol formation.
2. Increasing concentration of hydrogen: methane, due to necessary drop in temperature; increasing saturation.
3. Decreasing concentration of hydrogen: olefin formation.
4. Increasing temperature: methane and carbon.
5. Metallic catalysts in order of increasing saturation (less olefins): iron, cobalt, and nickel.
6. Presence of CO_2: inert; helps to act as a diluent.
7. With increase in the working life of the catalyst: relatively more benzine, less heavy oils.

The purpose of the synthesis was, of course, to produce the greatest quantity of benzine or motor fuel from domestic raw materials, and the discoveries have found their most praiseworthy results in the successful complete conversion of "synthesis gas" into benzine. But besides benzine, there are also produced Diesel fuels, lubricating oils of most excellent stability against oxidation, and finally solid hydrocarbons (paraffins). A part of the paraffin leaves the system as a vapor with the oil fractions due to the high local temperature of the contact catalyst, and this type of wax is easily removed from the paraffinic fractions by the usual methods of chilling and dewaxing. The paraffin thus obtained has an approximate melting point of 50° C., and consists of the saturated hydrocarbons containing 17 to 25 carbon atoms; this wax has been described by Koch and Ubing in *Brenn-stoff Chemie,* 1935, pp. 141-148; there was also described a so-called "hard paraffin," a type of wax, non-distillable with the oil-overhead fractions. This latter "hard paraffin" together with some exceedingly high-boiling-point oil remains on the catalyst due to the

very low vapor pressure of the former at the reaction temperature of approximately 200° C. The formation of hydrocarbons from "synthesis gas" is a progressive and strongly exothermic reaction, which necessitates external cooling of the reaction chambers or catalyst

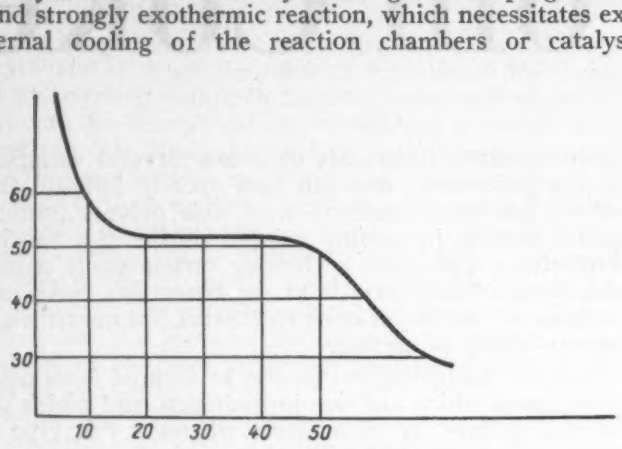


FIGURE 1

Solidification curve of paraffin.

towers. This cooling is obtained by a steam-boiler arrangement wherein steam can be produced by this excess heat of reaction. Calculations show that based on the fluid products produced, there are obtained 2 to 3 percent of this very hard wax or non-volatile paraffin. The contact mass will contain 1½ times its own weight of the hard wax, by absorption, without, however, its efficiency being in any way impaired. The best and most efficient contact material was, of course, found after testing out empirically many types of catalysts. Most efficient is a cobalt-thorium-kieselguhr catalyst, which will convert one cubic meter of "synthesis gas" to over 100 grams of liquid and solid hydrocarbons. Concerning the type of benzines and lubricants obtained mention should be made of their description in the *Proceedings of the Society of German Engineers,* No. 2, p. 49 ff. 1936.

What interests us now most of all are these exceedingly high-melting point hydrocarbons which remain behind on the contact catalyst. Their most valuable and unique property is that they have never existed in vapor form at any time, but were built up at and within the catalyst mass itself. The high-molecular-weight paraffins are well known to be unusually sensitive to high temperatures and will decompose into smaller or lower-molecular weight hydrocarbons. Koch and Ibing referred to above, have described this splitting tendency of these paraffins. For instance, a decomposition already was discernible at the low pressure of 10^{-5} mm. of mercury at 290° C. One can picture and visualize this extreme low pressure when it is considered that under such conditions of pressure one cubic centimeter of air will occupy a space of 100 cubic meters. These paraffin hydrocarbons melt at over 100° C., show molecular weights of up to 2000, and contain up to 150 carbon atoms per molecule. The exceedingly high-molecular-weight paraffins of over 2000 molecular weight show a melting point of 117° C. According to a private communication of Dr. Fischer, ceresins of even as high a melting point as 130° C. can be made. These types of waxes are sought without success in the commercial grades of wax; they are not found in commercial waxes which have been derived from any kind of distillation of paraffinic crude oil or tar oils, since such distillable waxes have been obtained by the crystallization of their distillates. If the desirable high-melting-point waxes had been present in crude oil to begin with they would have been cracked into lower molecular weight waxes during distillation. The above mentioned unique hard waxes will also not be found in residual stocks; though never vaporized or distilled, such stocks contain waxes which have been cracked due to the high temperatures to which such residues have been heated during distillation. One could at most expect to isolate them from the waxes which separate from crude oil during cold weather (rod wax) or from the naturally-occurring "earth wax," (ozokerite) since both these raw products have never at any time been exposed to high cracking temperatures, or converted at one time or another into the vapor state.

These same relations and conditions apply to synthetic "earth wax" or ceresin. It has been built up by the catalyst and due to its extremely high molecular weight, and therefore very low vapor pressure (high boiling point) has remained as a liquid during the reaction, and is found when cold deposited on the catalyst as a solid; it has never been in a vapor state. It was therefore to be expected that the synthetic wax would also show properties similar to the waxes mentioned above, which have not undergone any type of distillation or decomposition.

The writer had received from Dr. Fischer a larger

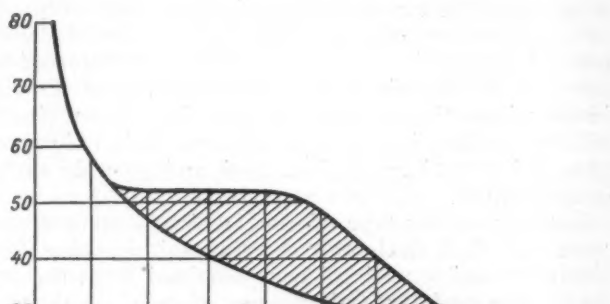


FIGURE 2

Solidification curve for paraffin; the resulting deviation from the normal path of the cooling curve due to the liberated heat of fusion is shaded.

working sample of both the bleached and unbleached wax obtained by extraction with solvents from the contact mass. The unbleached product appeared white with a trace of yellow grayish tint; the bleached product (by decolorizing clay) was snow white. Both were opaque compared with the usual grades of transparent paraffins and showed a melting point of 96° C. by the method of rotating thermometer bulb.

This melting point method, is the most conveninent method for rapid control work in plants manufacturing paraffin from lignite tars. It consists in the observation that a drop of the melted wax placed on the bulb of the thermometer will remain liquid while the thermometer is rotated on its horizontal axis, and there hang as a drop until it has reached the solidification point. As soon as it begins to solidify the droplet will completely cover the bulb as it is turned and coat it as an opaque layer. The temperature is read at this moment. For the accurate melting point determination of paraffin one employs Shukoff's method—determining the point at which the mercury thread of the thermometer remains constant during the solidification of the wax. The temperature remains constant at the solid point due to the liberated "heat of fusion"—that form

of heat made manifest again during the phenomenon of solidification. Here characteristic differences will be noted between ordinary paraffin and the synthetic wax.

Crystalline wax which can be distinguished from opaque ceresin by its transparency, shows quite a definite time interval during which the mercury thread of the thermometer remains at a certain temperature due to the evolution or liberation of the heat of crystallization (heat of fusion). In figure 1 is presented the cooling curve of paraffin wax. This is the cooling curve for a paraffin of 53° C. melting point. Figure 2 shows that portion of the cooling curve as shaded, which deviates from the normal cooling curve due to the liberated heat of solidification. In similar fashion were examined the solid hydrocarbons produced in the Fischer process from "synthesis-gas"; these hydrocarbons were solvent extracted from the contact catalyst; temperatures were read every minute. It was seen that this wax gave only a very slight deviation from the normal cooling curve during its solidification. The point of deviation coincided substantially with the melting-point as determined on the bulb of a rotating thermometer. For comparison two other waxes were also examined—both of guaranteed purity and containing no paraffin—one a sample of "earth wax" or ozokerite, the other a ceresin; both had been furnished me by the firm of Himmelbauer. The crude earth wax showed a melting point of 84° C., and the ceresin sample prepared from this ozokerite a melting point of 85° C., by rotating bulb method. Below are shown the cooling curves of these waxes in comparison with the synthetic ceresin.

These two waxes also show an insignificant deviation from the normal in the cooling curve, and this deviation again coincides with the melting point of the waxes determined by the rotating thermometer. One will note that these waxes show an even greater deviation from the normal than does the synthetic Fischer wax, and that they therefore show an appreciably greater amount of crystalline constituents than does the synthetic wax, which latter therefore is still more of an amorphous material than the naturally-occuring ceresins. One could of course assume that the natural waxes are composed of a large number of individual hydrocarbons of various melting points, which mutually influence the melting point of one another, and that the small quantities of heat of fusion which are liberated by the solidification of the individual hydrocarbons would necessarily determine or modify the apparent continuous direction or slope of the curve. The writer had investigated this question some time back in an endeavor to establish whether asphalts, being amorphous materials, could show a "heat of fusion." (See *Asphalt u. Teer-industrie Journal,* No. 35, 1926). If these amorphous hydrocarbons really consist of a great number of single crystalline hydrocarbons than the fact could be detected by their heat of solution upon dissolving such materials in some solvent. This heat of solution is necessary to solution, and which is of course withdrawn from the solvent itself. Therefore, the solvent would of necessity cool, and this so-called negative heat of solution agrees well with the heat of fusion. (Compare Graefe, *Chemical Review of the Fat and Rosin Industry,* No. 1, p. 5, 1910).

The writer has indicated in the *Journal for Asphalt and Tar Industry,* No. 35, p. 801, 1926, that this negative heat of solution is absent in the case of the amorphous hydrocarbons in contrast to the crystalline hydrocarbons, and which is again due to the very small amounts of crystalline material in the former, as is the case of the natural ceresin.

A marked difference between the amorphous and crystalline waxes is their solubility in solvents. We compared a hard wax of 58° C. melting point from lignite tar with a similar high-melting-point ceresin of approximately 56° C. (commercial grade)—the latter containing a little paraffin wax as an adulterant. One gram each of these waxes was dissolved in nine cubic centimeters of Sangajol, by warming and then allowing the mass to cool. The ceresin solution upon cooling became completely solidified, while the paraffin solution remained clear and fluid, with the deposit of only a few crystals. A three percent solution furthermore showed no greater crystal deposit, while the ceresin, in spite of its lower melting point, had solidified the greater part of the solution. Employing the pure ceresin from the Himmelbauer works, a three percent solution of it in Sangajol became completely solid.

Sangajol was chosen as a typical solvent approaching closely the properties of the so-called turpentine substitutes, which are used to dissolve ceresins on a commercial scale; this solvent is a distillate from Borneo crude oil. Ceresins are employed on a large scale for making polishes, etc., being excellently adapted in the form of floor polishes, for woodwork of all kinds, etc. The Sangajol is bound by the ceresin in a sort of paste, from which the wax later separates on rubbing. Besides ceresin there are also used carnauba, montan and other waxes for this purpose. It is imperative that these waxes form a solid mass with the greatest possible amount or percentage of solvent. Similar preparations are required for the shoe- and auto-polish industry. The writer has therefore tested a number of solidifying agents for their usefulness in this respect. Three percent blends of the desired wax were made up in Sangajol by warming up the solvent till solution had taken place, after which the mix was allowed to cool.

The effect of the various solvent "binders" tested out was as follows: (1) Fischer's synthetic paraffin, M.P. 96° C. gave complete solidification. (2) Lignite-tar hard paraffin, M.P. 58° C. gave no action. (3) A paraffin of 70° C. M.P. specially prepared from Borneo crude oil, gave good effect. (4) Commercial ceresin (adulterated with paraffin) M.P. 56° C. gave slight action. (5) Carnauba wax gave good effect. (6) Refined Montan wax gave bad effect. One clearly notes which solutions have more or less completely solidified, and which have remained clear, the latter showing no action or an unsatisfactory one. It is seen from these results that ceresin of the synthetic type is a very effective and excellent solvent-binding agent. Its much better properties compared with the 70° C. M.P. Borneo wax, which is not a commercial material, would bring it upon the market at a much higher price. This desirable higher price would have to be considerably higher than that of benzine. The by-product ceresin commands a higher price due to its special value even though in yield it is far below that of the benzine. It is questionable at present whether it is possible to employ the quantities produced for the purposes to which ceresin is especially useful. Eventually new outlets would have to be found; this is eventually possible and actually occurs when a new product is available for consumption. Fischer had already suggested to convert these waxy hydrocarbons into fatty acids by oxidation. One must nevertheless persist to endeavor to find new substitutes for carnauba, "earth wax" and the natural ceresin, all of which are imported, thus opening up new and promising possibilities for the still greater production of synthetic ceresin. Eventually, it is possible that synthetic ceresin will actually be exported, due to its very valuable properties.

Many Improvements in South Burbank Gasoline Plants

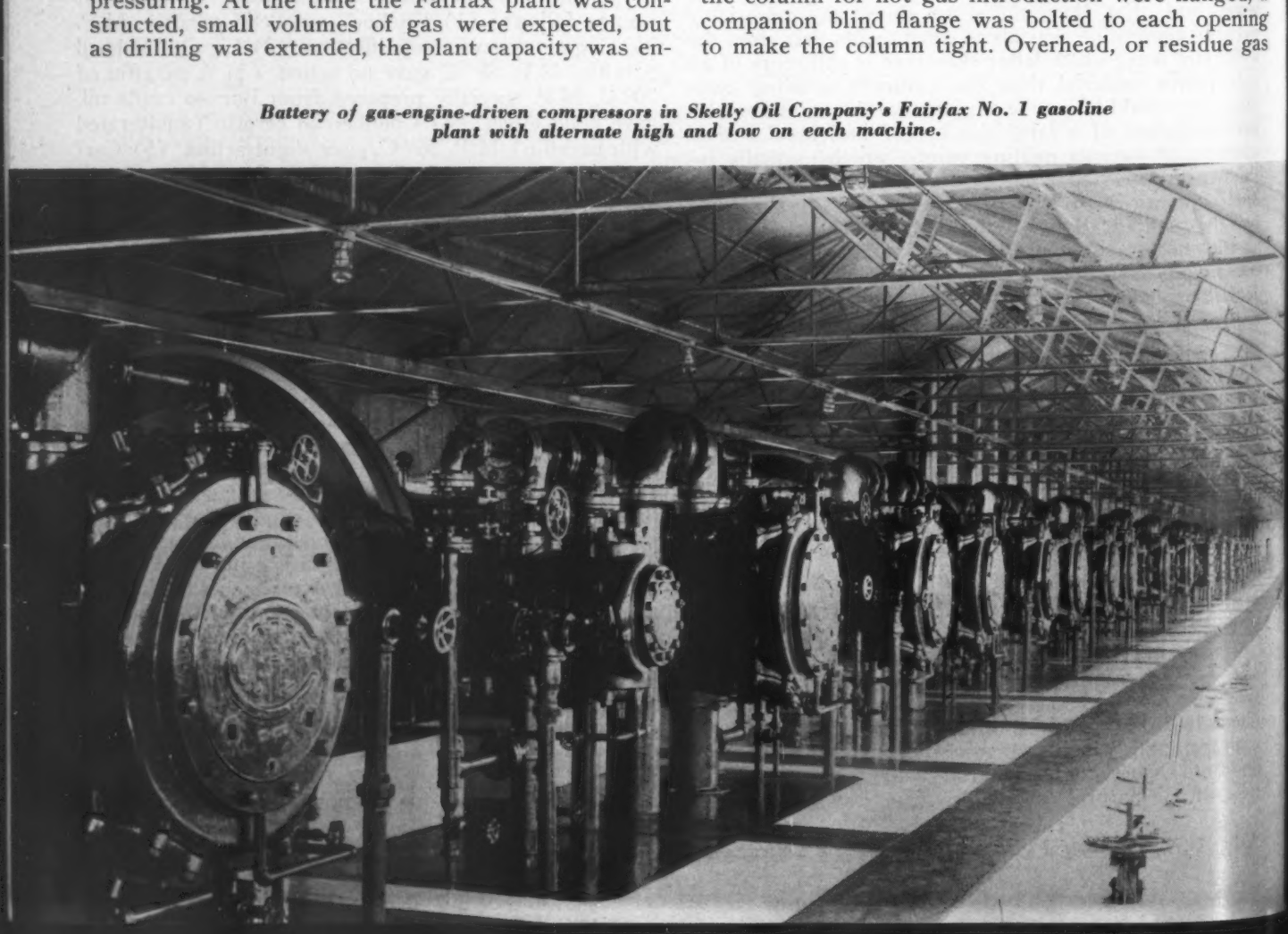
J. C. ALBRIGHT

WHEN oil was first discovered in the South Burbank field of Osage County, Oklahoma, the gas produced with the oil had a gasoline content of about two gallons. Since that time, due to a program of pressure maintenance upon the pool, the gasoline content gradually decreased until present recoveries average approximately one gallon per thousand cubic feet of gas. Gas not consumed in the field for drilling fuel and for gas engine operation is pumped back into the Burbank sand.

Skelly Oil Company constructed the first gasoline recovery plant in the field to care for outlying gas not included in the unit block, later taking over all gasoline production, including that handled by Carter Oil Company in its Presbury compression plant so the latter company could use its engine room for repressuring. At the time the Fairfax plant was constructed, small volumes of gas were expected, but as drilling was extended, the plant capacity was enlarged several times. The process included in the operation of the plant when it was first built was that of high-pressure gas fractionation, with a low-pressure absorber to care for casinghead gas taken from small wells to the south of the main pool.

When the gasoline content of the gas began to diminish consistently, the plant was converted from high-pressure gas fractionation to high-pressure absorption, using the original equipment with little change necessary to accomplish conversion. The same column was used for an obsorber formerly used as a high-pressure fractionator by cutting out the hot gas inlet nozzles and introducing the gas at the base of the column in the conventional absorption manner. As the connections originally placed on the shell of the column for hot gas introduction were flanged, a companion blind flange was bolted to each opening to make the column tight. Overhead, or residue gas

Battery of gas-engine-driven compressors in Skelly Oil Company's Fairfax No. 1 gasoline plant with alternate high and low on each machine.



connections were not disturbed in converting the tower to an absorber, as the stripped gas was taken off at a point above the top plate.

The column originally was equipped with a kettle, or reboiler for controlling the quality of the production secured by fractionation, and this was left setting in place when the change was made. Gas was made available for absorber operation by cutting into the vapor line between the outlet of the reboiler and the point where these vapors entered the column, placing the rich gas below the bottom bubble plate. The gasoline outlet from the reboiler, which had handled the gasoline recovered by gas fractionation, was left intact and equipped with the original liquid-level controls to handle the rich mineral-seal oil coming from the column as an absorber. No heat is used in the reboiler with the present type of operation, and the vessel forms an additional reservoir for the oil before it is vented to the distillation equipment.

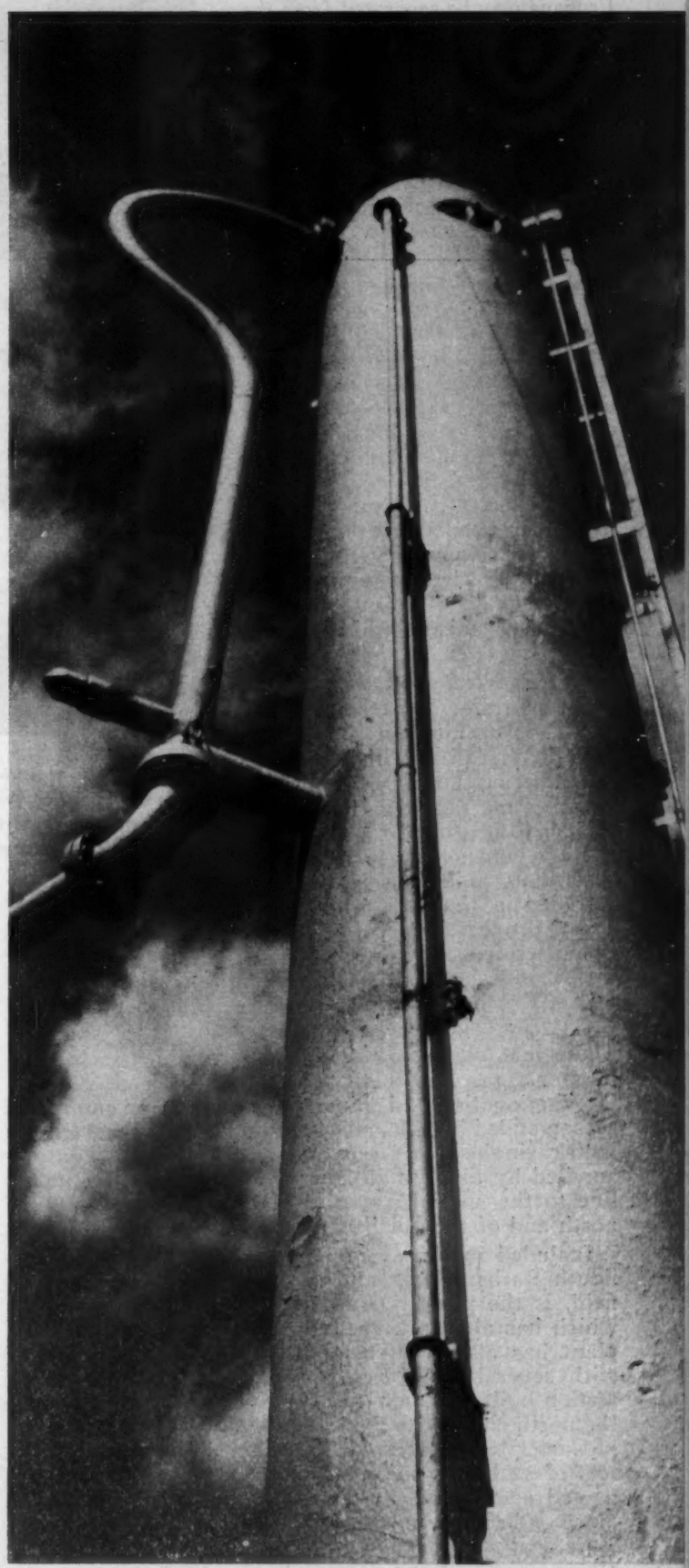
When the gas was introduced into the column for direct fractionation, it was at the temperature of compression. Needless to state that absorption requires cold oil, which was obtained by installing a sufficient number of open-type cooling sections in the louvre tower. Gas from the discharge of the high-pressure compressors under a pressure of about 275 pounds, gauge, is also cooled by passing through adequate cooling sections in the same tower. Circulation of the oil is obtained by using the gasoline reflux pump, originally used to control the top temperature of the tower, which is sufficiently large to circulate the required volume of oil to afford efficient extraction of the desirable hydrocarbons.

The plant is in effect two units, one for low-pressure processing, operating at about 45 pounds, and taking gas available from wells that are produced at or near atmosphere. This gas is handled in a more or less conventional manner and cooled and passed through the low pressure column with an oil-to-gas ratio of about 35 gallons per thousand cubic feet. The high-pressure gas is taken from traps which are at the wells in the unit area operating on controlled production, with the discharge header of the low-pressure machines connected to the intake header of the high-pressure machines in such a manner that all of the gas may be processed through the high-pressure absorber when boosted to the necessary pressure for processing. The connection was made in this plant so that if repairs are to be made on the low-pressure system, outside the engine room, the gas may be used without disturbing the operation of the field.

ONE DISTILLATION UNIT

Only one distillation unit is required to service the high- and low-pressure absorbers, as the streams of oil converge at the inlet of the heat exchangers. No appreciable difference has been found to exist between the characteristics of the gasoline from the different parts of the field and the combination production can readily be processed with fractionators to obtain any grade of gasoline required.

When the high-pressure system was operated as a direct gas fractionation unit, a special exchanger was used to cool the reflux and other portions of the plant, using expanded propane as the refrigerant. However, due to adequate cooling which results in satisfactory temperatures on both the oil and gas since the plant was converted to straight absorption, it has not been found necessary to lower the temperature of the absorption oil below that obtained by ordinary cooling.

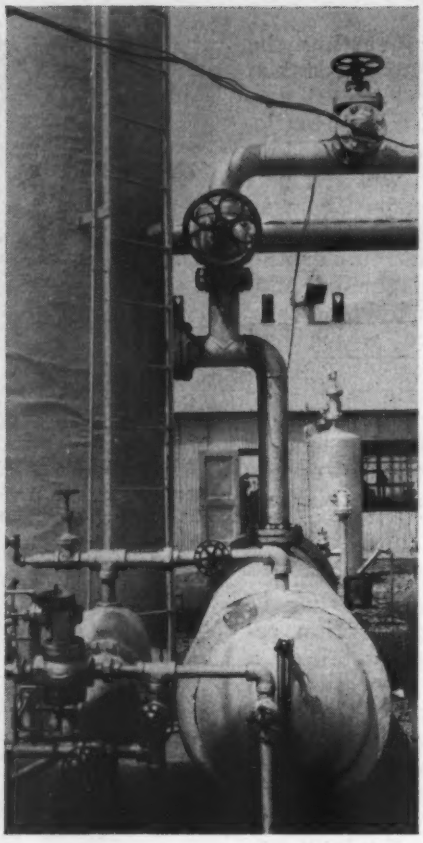


High pressure column recently converted from gas fractionation to absorption in Fairfax No. 1 gasoline plant of Skelly Oil Company, Osage County, Oklahoma.

Propane may be separated from the raw natural gasoline in this plant, as the original fractionator is ready to be used again, but since all the raw production from the plants operated by Skelly Oil Company in the Osage is processed in the special products plant at Lyman, it has not been necessary to manufacture any other product than raw natural at Fairfax No. 1.

At the same time that the plant was converted from one type of operation to another, additional engines were required to handle the large amount of gas available, due to extensions of the field and because of the great amount of gas recycled while maintaining the reservoir pressure. Engine jacket water in volumes sufficient to obtain the desired temperature on the power and gas compressing cylinders is obtained by circulating over two modern water coolers installed above steel tankage behind the engine room.

Fairfax No. 2 plant, while an entirely separate unit from Fairfax No. 1, is operated in conjunction with the first plant with the system of gathering lines interconnected. At the same time the change-over was made at plant No. 1 from hot-gas fractionation to high-pressure absorption, additional engines were installed in No. 2 to relieve the load upon the field and to prevent the escape and waste of gas. The same pressures are maintained upon the absorption unit in the second plant as that on the high-pressure system in No. 1 so that all residue gas can be used in repressuring the field.



Method of connecting gas to column when converting from high pressure gas fractionation to high pressure absorption.

Original plans and operation procedure included pumping gasoline from the second plant to No. 1 for fractionation and shipment, but since the summer season ended in 1936, all gasoline manufactured from both casinghead and separator gas in Osage County, handled by Skelly Oil Company, is pumped by pipe line to the special products plant at Lyman, in the north end of the old Burbank field.

Included in the system of gasoline plants in the South Burbank area, and in the south end of the old field, is the plant operated by Skelly Oil Company which has always been known as Carter Nine. This plant has also been reconditioned and modernized, with several additional compressors and a booster station built to handle newly-produced gas. Gas from the north end of the South Burbank field is processed in Carter Nine, received through a disconnected system of gathering lines, which were at one time connected so that all three plants could draw upon a more or less common source of supply.

In addition to the new engines installed in Carter Nine a research laboratory is provided so that all technical problems affecting the field as a whole can be handled from a common point. Three fractionation columns are installed in this laboratory so that analysis can be made on any gas being processed or contemplated. Water problems are worked out in this laboratory to determine what method of treatment can be applied to cooling and boiler-feed waters to eliminate corrosion and oxidation of metals.

A pipe reconditioning plant is installed to salvage all surplus and damaged equipment. Sand blasting equipment for cleaning gates, valves, tanks and pipe is being set up, together with electric welding units for repairs and fabricating various articles needed in the plants in this territory. Advantage is taken of the concrete floors of buildings removed to install the reconditioning equipment, and crushed rock is spread over the yard to relieve the soil conditions when wet weather is encountered.

When the new engines were installed in Carter Nine to handle additional gas, the intake headers were changed by elevating them directly above the compressor cylinders, instead of leaving them in the ground covered by the concrete floor. The intake piping was suspended in the roof of the building by extending the header across the struts and supporting members of the roof. Connections to the cylinders are directly down and were made by welding individual intake lines to the header directly above the intake flange. Control of the volume to each cylinder is now accomplished through lubricated plug stops set at convenient distances above the cylinders. Discharge gates in this plant were not disturbed, and are operated from outside the engine room in the usual manner.

The new water system installed to cool the additional engines includes a steel tank equipped with a modern water cooling tower mounted directly above the tank and supported by legs resting on the bottom deck of the vessel. Water is handled through two hot wells, one at the north end of the building and one at the south end. Each well is serviced by electric pumps, and the south unit runs at capacity at all times, with the controlling devices in the north hot well.

Like the two plants in the south end of the Burbank extension, Carter Nine does not stabilize or fractionate any of its production to definite grades of gasoline. While equipment is in place, as well as treating equipment, handling gasoline for definite production is not practiced at this time; pumping all raw gasoline to Lyman through a pipe line common to all three plants for cutting into various fractions above propane and butane.

Extensions were only recently made by building a new pipe line from the booster station, southeast of the plant, so that more gas can be processed Residue from Carter Nine is returned to the field for fuel as well as being compressed to about 750 pounds for reintroduction into the sand of the northeast extension to maintain reservoir pressures.

Carbon Dioxide for Fire Protection

JOHN F. KIDDE
Walter Kidde & Company, Inc.

PRIOR to 1926 little was known of the value of carbon dioxide as a fire-extinguishing agent. Considerable research had been made following the success which had been shown by large marine interests in adopting this new method of fire extinguishment. About three years later and shortly after the installation of a carbon dioxide wheeled extinguisher in a Texas refinery a serious fire broke out in the refinery caused by a leak at a hot-oil pump. Available portable equipment was ineffective because the oil streaming from the leak could not be shut off. A carbon dioxide extinguisher was brought from another building and the fire was instantly extinguished. Many similar experiences during the past 10 years have proven the value of carbon dioxide extinguishers to the industry. During that time the design of the equipment has been changed to make it more efficient and more adaptable to the hazards found in dealing with oil fires. The remarkable efficiency, ease of operation, lack of skill required to use it properly and non-freezing qualities have made this type of equipment acceptable to the industry for the protection of its most severe hazards.

All carbon dioxide type of extinguishers use liquid carbon dioxide under its own pressure in steel cylinders. Upon release, the liquid carbon dioxide is conveyed to a nozzle where the discharge, consisting of a snow an heavy gas, makes it equally effective indoors and outdoors.

Carbon dioxide fire-extinguishing equipment is utilized in the form of portable or mobile units and fixed systems. There are 9 different sizes of portable or mobile extinguishers varying in capacity from 2 to 100 pounds. The size of the fixed systems is dependent upon the hazard to be protected and may consist of from one to several hundred cylinders manifolded together, each cylinder containing 50 pounds of carbon dioxide. In the case of the portable or mobile equipment, the discharge from the extinguisher is applied directly to the fire.

Fixed systems may be either of two types; first, total flooding; second, local application. On total-flooding systems, the entire space involving the hazard is filled with carbon dioxide, thus reducing the percentage of oxygen so that fire cannot exist. The local-application type of protection is similar to the use of portable or mobile equipment in that the discharge must strike the fire. However, the discharge nozzles are fixed rather than movable. Operation of either the total-flooding or local-application systems may be automatic or manual.

A review of the hazards found in the oil industry will be helpful in consideration of the value of carbon dioxide equipment in the industry.

REFINERIES

On hazards such as centrifuge rooms, test laboratories, pump houses, and similar locations which may be important parts of a process or costly to replace, the fixed system of carbon dioxide extinguishing is employed. Due to lack of damage by the extinguishing medium as well as prompt extinguishment, a minimum of delay and loss results at time of fire. Experience on many such fires shows that production is delayed but a few minutes.

In such cases where automatic systems are installed, the fire is automatically detected in 7 to 12 seconds and extinguishment is accomplished within another 30 seconds. The entire space is filled with carbon dioxide gas and regardless of the type of location of fire, whether due to broken lines causing flowing fire or confined to equipment, the fire is promptly extinguished.

LABORATORIES

Carbon dioxide was perhaps more readily accepted in laboratories than in any other branch of the oil industry. The advantages of the equipment, because of its chemical aspect, was quickly recognized.

In some laboratories the quantity of flammable liquid involved is not great and in such cases, carbon dioxide portable equipment has quickly extinguished many fires in the matter of seconds, without damage to the equipment or test and experimental material in process. The lack of damage precludes the possibility of costly delay in obtaining new samples of oil or gasoline which may have been under test at the time of the fire. The soft discharge from the extinguisher will not upset or break glassware containing flammable liquid thereby increasing size of fire.

LOADING RACKS

Recently a tank car of gasoline was derailed while being shunted onto a bulk station siding near Boston. The bottom boot was broken off and the valve damaged so that it leaked a heavy spray. A friction spark during the derailment evidently ignited this for a threatening fire ensued.

Before the gasoline in the car became heated, an

employee of the bulk station extinguished the fire with a portable carbon dioxide extinguisher. He had no difficulty even though gasoline was burning on the ground and in the stream from the damaged valve.

At any point where loading or unloading may occur, fires can result from spill-overs or leaks and possibly from broken connections or pipes. On such hazards, the carbon dioxide type of extinguisher can be kept at the hazard regardless of temperature, in view of its non-freezing qualities, thereby providing easily and quickly available equipment. It is well appreciated that spill fires and running fires in gasoline or oil fires are difficult to extinguish.

ELECTRICAL EQUIPMENT

In view of the fact that carbon dioxide is a non-conductor of electricity, it is suitable for and has been found to be the most efficient type equipment for electrical hazards such as motors for pumps, generators, or oil switches, and transformers as found in power plants. Many such fires involve both electrical and oil or gasoline fires. Therefore, a carbon dioxide extinguisher which is suitable and efficient on both types of fires provides adequate protection. The carbon dioxide gas is non-toxic, has no irritating effect on the operator and can be used with efficiency and safety.

SPECIAL GASES

With the increased demand for propane, butane and similar gases which are manufactured in refineries, a new type of risk is involved. Tests have been conducted by a number of the oil companies which prove that carbon dioxide extinguishers can cope successfully with such fires in these cases. It must be appreciated that in this type of fire, there is no surface on which a liquid can be discharged and that it is necessary to extinguish the fire by surrounding the entire flame with an extinguishing medium.

BULK PLANTS

In bulk plants, the hazards to be considered are the loading racks, pump room and garages. In the major portion of the cases, an extinguisher of a non-freezing type is necessary since it is highly desirable to keep the extinguishers close to the hazard at all times. In view of the non-freezing qualities of the carbon dioxide extinguisher, this unit can be installed on loading racks and in unheated pump houses and garages.

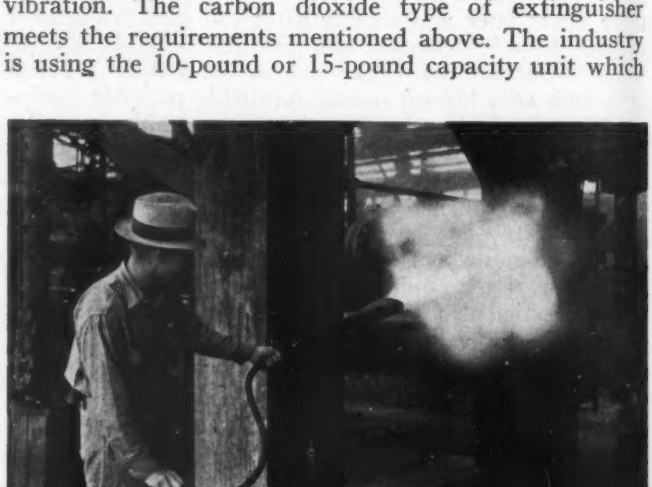
Since the equipment is in place throughout the year, the operators unconsciously become familiar with its operation and use, and further know its exact location at time of emergency.

At the loading rack, spill fires, running fires or truck fires do occur and many such fires have been quickly extinguished by carbon dioxide equipment.

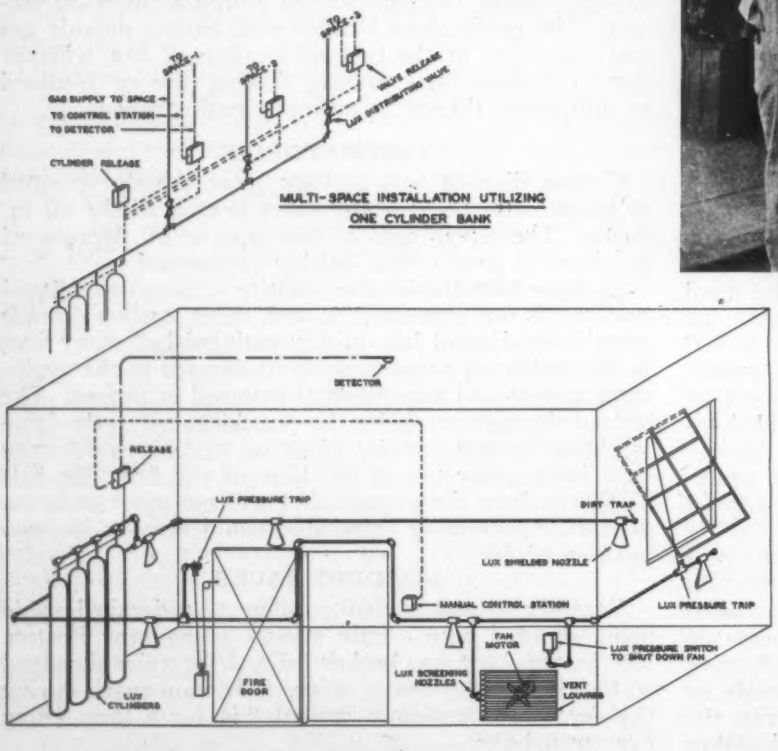
In pump rooms, fire may be due to electrical breakdown or broken and leaky fittings in pipe lines conveying the gasoline or oil. Rather than have one type of extinguisher for electrical fires and one type for gasoline and oil fires, the carbon dioxide type of extinguisher answers both requirements.

TRUCK PROTECTION

Fires occurring on trucks generally are due to overheated motors, static electricity or ignition of vapors by hot exhaust. The extinguishers to be provided must be of a non-freeze type and capable of coping with running gasoline or spill fires. The extinguishers should be rugged in design, capable of withstanding severe vibration. The carbon dioxide type of extinguisher meets the requirements mentioned above. The industry is using the 10-pound or 15-pound capacity unit which is mounted in specially designed holding brackets on the running board or catwalk.



Recently before the Pan American Petroleum Transport Company completed its refinery at Texas City a very thorough study was made of every fire hazard that might be present in that plant. Details of installation are only available from the company itself but carbon dioxide here plays the major roll both in the line of first defense, which includes portable equipment, and also in the more serious job of fire protection where piped systems costing thousands of dollars are dependent upon for the ever-present and serious hazards of all fires.



Gas Conservation

Efficient Utilization Provided By Modern Gasoline Plant

F. P. PETERSON
Engineer, Southern Minerals Corporation

IMPORTANT strides are being made along the South Texas Gulf Coast in the conservation of gas, by establishment of markets for products previously popped into the air. While gasoline plants are not new to South Texas, improved units and operation are being perfected.

In the Saxet field, Southern Minerals Corporation has devised an entirely new system, in which gas is being taken from wells under various pressures. By installation of proper control equipment, the wells are so controlled as to produce efficiently and at the same time enable operation of the plant at a steady rate.

The residue gas separated from the oils are handled through the natural gasoline plant. The gasoline goes to storage, while the dry tail gas is available for several uses. It is planned to erect the first South Texas carbon black plant to absorb that portion of tail gas not being used now. The gasoline stripped from the gas is blended again with the crude.

THE natural gasoline absorption unit, recently completed by Southern Minerals Corporation, is located 10 miles west of Corpus Christi and a mile and a half north of Clarkwood, Nueces County. The Saxet plant, as it is named, has a rated capacity of 20,000 M.C.F. daily at 30 pounds pressure.

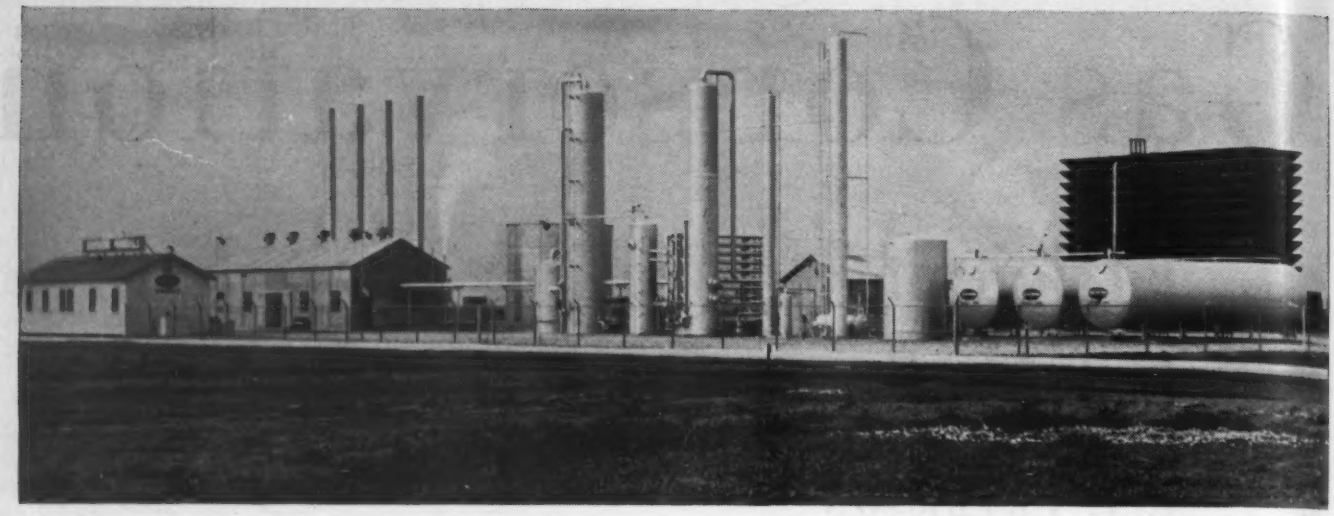
Preliminary studies of the field were made last fall, through September and October. Gas measurements were taken, using a pitot tube for calculating volumes. Samples were gathered from representative wells and sent into a commercial laboratory for low temperature fractional distillation analyses. These were used, in preference to charcoal tests, to form a composite picture of the entire field. A typical analysis of the present inlet gas is given in Table 1. At this time, the major portion of this gas is being taken from wells producing from the 5800-foot Frio sand.

The gas gathering system consists of two main headers of 10-inch spiral welded pipe with laterals of 6-inch, 4-inch, and 2-inch standard line pipe. The main headers, including a 16-inch meter run to the inlet scrubber, are welded. All the laterals are screwed lines. As the soil conditions in the area are somewhat corrosive, special precautions were taken and the entire gas gathering system has been treated with an asphalt base coating. There are altogether 10 miles of pipe in the system, made up of two miles of 10-inch, 1¾ miles of 6-inch, 4¼ miles of 4-inch, and two miles of 2-inch. At this time, 120 producing wells are tied in with the gathering system.

OF LATEST DESIGN

The Saxet plant is of the latest design, incorporating the best features of a conventional well-pressure type unit. Construction throughout is welded, and all pressure vessels conform to the A.S.M.E. code for unfired vessels. Both absorbers, the main absorber and the reabsorber, have 16 trays and are equipped with double mist extractors. The main absorber has a rated capacity of 20,000 M.C.F. at 30 pounds. The rich oil is pumped from the primary absorber through a bank of 12 heat exchangers. The oil is then vented before being returned to a second bank of six heat exchangers. Finally, the rich oil is passed through a steam preheater and into a combination still-dephlegmator unit. The still has 11 trays with a built-in vent section. The two bottom trays are fitted with built-in heating elements. These elements permit a reduction in the partial pressure steam required because of a higher temperature in the still base. Exhaust steam from the make room pumps is superheated and serves as agitation steam for the still. Top and base temperatures are 230 and 375° F., respectively. The still-dephlegmator is operated at 60 pounds gauge pressure. A gasoline reflux is used to control end point and condense agitation steam. Vapors from the rich oil vent and raw make tanks are sent to the reabsorber. The stripped or lean oil from the still base is passed back through the heat exchanger bank and into a surge tank. From there, the lean oil is pumped out into three parallel banks of atmospheric coolers before the cycle is completed through the main absorber and reabsorber.

The centrifugal pumps, handling a 41° A.P.I. kerosene absorption oil, are steam turbine driven tandem units. These circulating pumps are duplicated for standby service. Reflux, transfer, feed and loading pumps in the make room are direct acting, simplex pumps. Raw make and reflux pumps for the fractionating column are low clearance, direct acting simplex pumps designed for this type of duty. Gasoline vapors from the top of the dephlegmator are passed through two banks of primary condensers in parallel and a final condenser in series. The heavier ends, condensed in the primary sec-



Southern Mineral Corporation's Saxet Gasoline Plant

tion, serve as the gasoline reflux for the dephlegmator. The raw gasoline, from the final condenser, is pumped from the make tank through heat exchangers into the fractionating column. The lighter components, including a portion of the butane and all of the propane, ethane, and methane are cut out as overhead products in the fractionator. The overhead is partially condensed in an atmospheric, open type reflux coil. The condensate, consisting almost entirely of butanes, is returned to the column as reflux. The uncondensed vapors are released through the residue gas vent.

The finished product, from the base of the fractionator or kettle, is sent through heat exchangers and into a final cooler before passing into the storage tanks. The fractionator unit has a rated capacity of 25,000 gallons per day of a 26-70 finished product. At lower column capacities it is of course possible to make a range of products down to a butane free grade by simply varying the operating pressure and temperature conditions.

OPERATIONS AUTOMATIC

Insofar as it is possible, operations throughout the plant have been made automatic. All the controls and indicating flow meters are located on a common panel in the make room. Indicating flow meters have been placed on the oil lines to the absorbers, on the partial pressure steam line to the still, on the reflux line to dephlegmator, and on the reflux line to the fractionating column, thus permitting an accurate analysis of operations at all times.

TABLE 1

Analysis of Composite Gas—Sample from Saxet Field

Methane	91.72% by volume
Ethane	3.86
Propane	2.01
Iso-Butane	0.23
N-Butane	0.99
Iso-Pentane	0.20
N-Pentane	0.36
Hexanes and heavier	0.63

An open type atmospheric cooling tower was selected as being suitable to conditions along the Gulf Coast. This is an eight-bay unit constructed from California Redwood. The louvres are fitted with drift retrievers. The atmospheric coolers and condensers have admiralty metal tubes and steel tube sheets. A pit for the water circulating pumps has been provided so that at all times the pumps have a small head on the suction side. These centrifugal pumps are driven by steam turbines and are duplicated for a stand-by service. The piping for one has been so arranged that this unit serves as a plant yard fire pump. These pumps have a rated capacity of 1500 gallons per minute with a 75-foot head. Inasmuch as the plant is supplied with raw river water from a line nearly three miles distant, and under pressure at all times, a 2000-barrel emergency storage tank has been placed directly behind the boiler house. This supply would serve for a 36-hour period in the event of a line failure.

The boiler room layout incorporates several new features. The four 125 horsepower 200 pound working pressure oil country boilers are supported on built-up steel foundations. Steel skirts, fitted with sliding doors, control the air supply. Makeup water is fed through a three-stage system consisting of an atmospheric heater and deaerator, a low-pressure condensate receiver, and a high-pressure condensate tank. Condensate is returned to the latter from the preheater and superheater at 125 pounds gauge. This arrangement furnishes an unusually high feed water temperature of 353° F., and in addition serves to precipitate all of the carbonates and the majority of the sulphates present in the raw feed.

An analysis of the raw water from Nueces River is given in Table 2. Feedwater and residue fuel gas are automatically regulated with changes of boiler loads. A gas engine driven, 17 kilowatt, alternating current generator is sufficiently large to permit the use of small vapor proof motors in the plant yard, besides furnishing current for plant, office, and camp lighting.

Finished product storage at the plant consists of three 10 x 40 tanks. This is small because of the fact that the finished gasoline is pumped out almost daily to the ocean loading terminal located on the turning basin through a 3-inch line 6½ miles long.

Soil conditions present a peculiar problem with foun-

TABLE 2

Analysis of Raw Water—Nueces River, Calallen

Total Hardness—as $Ca\ CO_3$	14.5 grains per gallon
Bicarbonates—as $Ca\ CO_3$	11.7
Chlorides—as NaCl	13.7
Dissolved Silicia—as $Si\ O_2$	12.3 p. p. m.
Suspended Silicia—as $Si\ O_2$	10.7
Alumina	1.7

dations in this area. An alluvial deposit that swells and contracts with wet and dry weather conditions has an average thickness of from 20 to 25 feet. The obvious solution has been to spread out the bearing load over a properly designed and reinforced concrete slab that will resist this contraction and expansion.

Construction was started with the first week in January of this year. Weather conditions were ideal. The plant was placed in operation March 10, or a little over two months later. Operations have been continuous since then without shutdown. Since January 1, the field has enlarged to such an extent, with the deeper productive zones, that the plant is now operating at 40 percent overload. These new sands are in the 6300-foot, the 6700-foot, and the 6900-foot levels. Complete operating data, furnishing an analysis of plant operation, has not been included with this article because of the present overload. It is interesting to note, however, that the 18 pound R. V. P. finished product that the Saxet plant is making at this time has an octane number of 79.6.

A contract, on a turn-key basis, has recently been let for the installation of new equipment that should rectify this abnormal condition of plant operation. The new unit will include a duplication of the present absorber group, the installation of a 255-ton butane refrigerating system, a propane-butane recovery unit, and storage facilities for the finished grades of propane and butane.

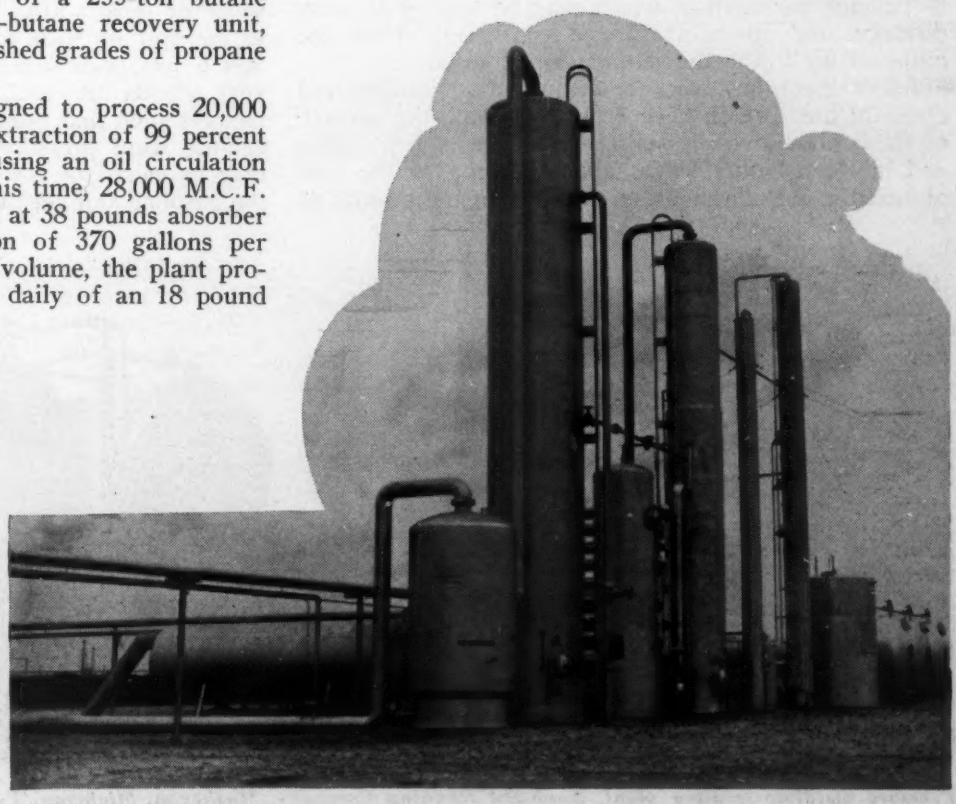
The plant was originally designed to process 20,000 M.C.F. of gas per day for an extraction of 99 percent plus, of pentanes and heavier using an oil circulation of 326 gallons per minute. At this time, 28,000 M.C.F. of gas per day are being treated, at 38 pounds absorber pressure, with an oil circulation of 370 gallons per minute. With the increased gas volume, the plant production averages 10,500 gallons daily of an 18 pound R. V. P. finished product. After the new absorber group has been installed, the plant pressure will be reduced to 30 pounds gauge for a total expected gas volume of 40,000 M.C.F. per day.

Averaged with yearly atmospheric conditions in this area, the butane refrigerating system will permit a 30 degree drop in the lean absorption oil temperature. This reduction in temperature will be equivalent of a 60 percent increase in the plant absorption factor.

An anticipated recovery of approximately 7500 gallons of butane daily will furnish an immediate supply for the market demands of South Texas. The propane-butane unit should be in operation by the middle of June.

Contracts have been submitted to Southern Minerals Corporation for the utilization of residue gas in a carbon black plant. Laboratory and field tests on this gas have indicated a commercial recovery of 1.3 pounds of carbon black per 1000 cubic feet. With a total of from 30 to 40 pounds of pure carbon available per 1000 cubic feet of average residue gas, a fair idea may be gained as to the efficiency of present day methods of carbon black extraction. In this instance, a maximum of 4.3 percent would be recovered. Inasmuch as Southern Minerals is definitely pledged to a policy of gas conservation for industrial usage, and since the parent company, Southern Alkali Corporation, is in the chemical manufacturing industry, sale of the residue gas to chemical plants producing solvents will be given preference. A tentative pipe line right-of-way and plant site have already been selected.

Plant operations are under the direction of D. H. Hancock, field superintendent, and H. H. Hiatt, plant superintendent.



Absorber group with distillation unit and fractionating column in background.

Treating Columns Designed for Flexibility

TREATING gasoline or pressure distillate often requires a contacting column that can be moved from one location to another, or taken down altogether when making repairs or adding equipment. When these columns have been erected upon a permanent foundation, such as brick, concrete or any other substantial footing, it is difficult to move them for making adjustments without dismantling the entire unit. While permanency in installing any equipment has its advantages, flexibility in operating the units may be improved when the columns are not bolted to a heavy foundation, but merely set upon the ground at the point of use.

Naph-Sol Refining Company at Muskegon, Michigan, skims, cracks and manufactures technical naphthas from local crude, with treating accomplished at the several units, using first one process and another, depending upon the type of products manufactured and results desired. In its pressure-distillate treating plant, several contacting columns are required to scrub out the hydrogen sulfide present, using a caustic solution, and this is followed by contacting with doctor solution. The contacting columns were made in the refinery shops.

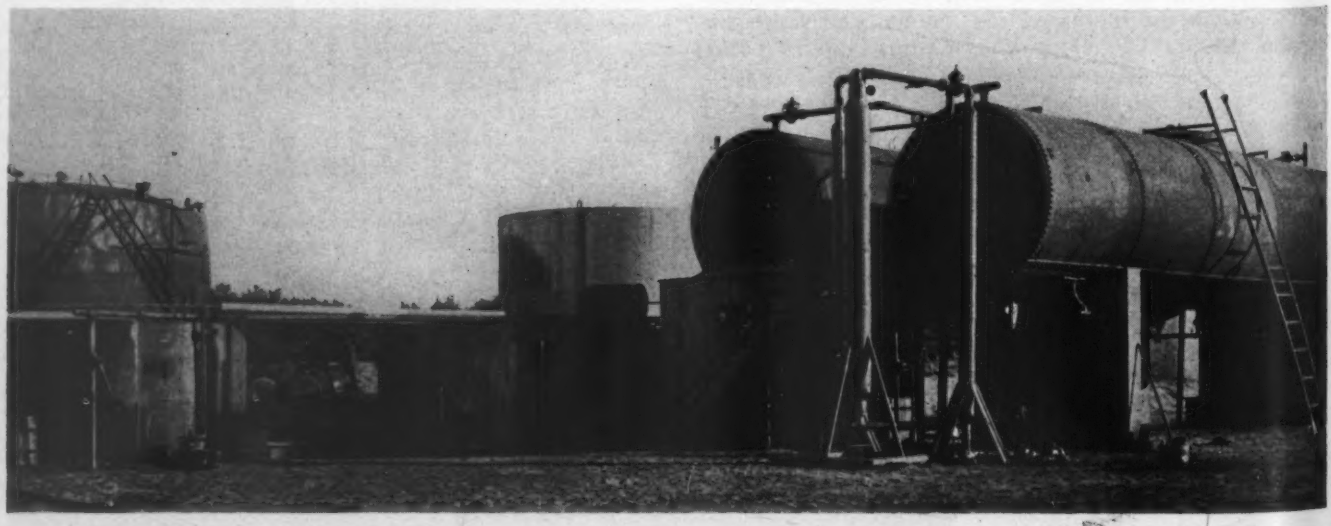
The columns were made along the more conventional lines, using pipe of different diameters, depending upon the use to which they were to be put, and installing baffles at predetermined points. All of the columns employ the bottom-to-top flow, with cracked gasoline or pressure distillate and treating chemicals entering at the lower connection. Some of the columns are used when the distillate and chemicals are to be transferred to tankage for settling, which may be located at some distance, and others are connected directly from the outlet at the top to the settler near at hand.

All of them, however, are connected to gasoline and chemical lines which have been laid below the surface of the light sandy soil, having control and service gates and lubricated plug valves above the top of the soil, or cased in metallic housings inserted in the ground to protect the fittings yet make them accessible. One in particular was located so near one of the settling tanks, which were made of tank car shells, that it could be used as a support for a landing so the operator can inspect the operation of the columns and settling tanks.

The supports which hold these columns in an upright position were constructed principally of two-inch piping, welded, the ends of each piece to form a rectangle. When the heaviest columns were to be mounted upon these foundations, a nipple was welded across from one side to another to present a greater bearing surface, and prevent sinking into the light sandy soil of the refinery yard. Adequate bracing was applied to the columns, attached to the sides by welding as well as fastening the lower ends to the rectangular base.

Braces were used, principally of angle irons, doubled for greater strength, with the flat sides placed outward so that sharp edges would be exposed. Pipe braces have been used and secured as rigid construction as when other shapes of steel were used. The dimensions of the rectangle differ with the column, some of which are heavier, and require a more substantial foundation than the lighter contactors.

As all of the columns were made in the shop, and form a complete unit, any of them may be moved from one treating plant to another or removed to the shop for repairs after cleaning and steaming. Obviously the cost of such column and support is not great, and it has been said that they can be operated with very gratifying results. The size of the rectangular basis is such that none of the columns require guying against wind pressure, and, by using a shovel, they may be raised or lowered to suit any connections on the gasoline and chemical lines.



Pressure distillate treating plant, Naph-Sol Refining Company, Muskegon, Michigan. Type of soil at plant site is shown as is type of bases for treating columns which makes them easily movable.

Head Work and a Kodak ...*Suit Dropped*

WHEN the waste oil pit was flooded by a sudden torrential downpour, the refinery yard gang went after what heavy oil got off the property and with logs and hastily thrown up diversion levees, managed to corral and burn practically all of the heavy sludge, only occasional black rings on tree trunks and smudged leaves on underbrush remaining to mark its passage.

Three weeks after the storm the refinery office was visited by two men who lost no time in introducing themselves as an attorney and his client, the owner of a small dairy herd which, they claimed, had been pastured since before the flooding rain some half-mile away from the refinery, and whose pasturage was watered by the small stream trickling past the grounds, and into which the waste oil had been carried.

After stating their premises, the attorney presented a staggering bill, included in which were listed some half dozen fine, blooded milch cows, all alleged to have died from drinking oil-polluted water. The statement also listed a daily item purporting to cover value of decrease in milk given by surviving members of the herd, the drop in output being ascribed to the sudden shutting off of proper drinking water for the animals.

Their own counsel advised the refinery to compromise, stating as their opinion that if the case came to trial before an agrarian jury damages in excess of the —admittedly exorbitant—bill in all probability would be awarded.

All the assistant superintendent of the refinery could do was to gain a week's delay, at the end of which the dairyman and his attorney threatened instant filing of suit if the claim was not satisfied.

In the short time at his disposal, the assistant covered the terrain cleaned up by the yard gang, and followed the winding water-course down to the alleged pasture fence. In the eddies and quiet pools, there still swam small patches of black oil, heavy, viscous, and not spreading over the water as fresh crude should—and usually did. To all appearances, the clean-up had not been thorough enough, and some of the heavy waste ends were still gathering and floating slowly down the stream.

Prompted solely by curiosity, the assistant skimmed enough of the oil into a bottle to enable the refinery chemist to run an analysis. To their mutual surprise, the salvaged oil showed no sulphur, while a check-up of the waste pit showed that element in every specimen obtainable there.

Starting from the conclusion that the oil he had skimmed off the stream must have come from a source foreign to the refinery, the assistant haunted the stream for five of the seven days of grace, without finding anything which he could tie in with the chemist's report.

On the sixth day he again observed scattered oil bodies afloat on the water, and back-tracked them from near the dairy pasture fence to the refinery enclosure. There he proved the oil was not seeping through the waste pit dam, but was being carried down the other branch of the stream. Up this, he finally found the oil

Along the left of the mirror-like water surface appear the tell-tale streaks of black oil.

was emerging from two drains which emptied into the stream. One drained an oil-fired boiler house, the other served a nearby railroad yard where tank cars were even then being steamed out after unloading a shipment of fuel oil to the railroad's storage tanks.

Hastily pressing two disinterested men into services as witnesses, the assistant superintendent went back to the outlets to both drains and with his camera obtained snapshots of the surface of the stream, in each case black splotches showing the oil floating on the surface.

Confronted by these photographs, and with the task of proving the origin of the oil alleged to have occasioned the loss from among three possible sources, the complaining attorney hastily renewed his suggestion of compromise, and when balked, slammed from the refinery office, blustering that suit would be filed.

That suit has never been filed and the pictures, representing a total cash outlay of perhaps 30 cents, are credited with having saved the refinery several hundred times their cost.

IDEAS to help plant efficiency

Expansion Joint on Exhaust Lines

IN order to eliminate possibilities of leaks developing in exhaust lines attached to the power cylinders of gas engines, Skelly Oil Company employes designed and applied expansion joints where the usual removable sleeves are used. Material used was heavy boiler plate, cut in circular form and dished. Two pieces were

Expansion Joint in Exhaust Line

necessary for each joint, and after being formed and welded at the outer rims, they were attached to short nipples which screw into the exhaust stool of the engine and into companion flanges so sufficient piping can be used to carry the exhaust from the building. Several of the older type engines which will not permit overhead exhaust were equipped recently with these joints, and they are said to be giving excellent service.

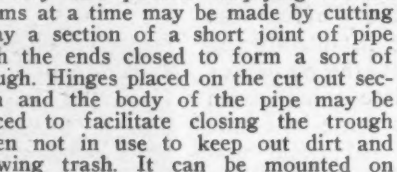
Drip Funnel for Emptying Drums

WHEN drips are picked up in the field in quantities that will not justify the use of a tank wagon, or where the surface of the ground is such that a team is more satisfactory, drums are often used to contain the gasoline while hauling into the plant. Filling the drums at the drip connections is not much of a chore, but when it comes to pouring the gasoline into funnels which lead to storage or rerunning equipment the job becomes more difficult.

A simple piece of equipment that is satisfactory and permits emptying several drums at a time may be made by cutting away a section of a short joint of pipe with the ends closed to form a sort of trough. Hinges placed on the cut out section and the body of the pipe may be placed to facilitate closing the trough when not in use to keep out dirt and blowing trash. It can be mounted on standards at a convenient height so that drums may be unloaded from a wagon or truck, using a platform upon which to roll the full drums when bringing them in from the field. A welded nipple on the lower side of the trough connected to a pipe line leading to a blow case or tank with no pressure completes the installation.

Rapid Method for Evaporation

IN water analysis it is required that a certain amount of water be evaporated to dryness in order to determine the total solids contained in the water and to obtain



Arrangement for Rapid Evaporation

enough of these solids for analysis. In dealing with water containing a low percentage of solids, a large amount will need to be evaporated, resulting in a time-consuming procedure.

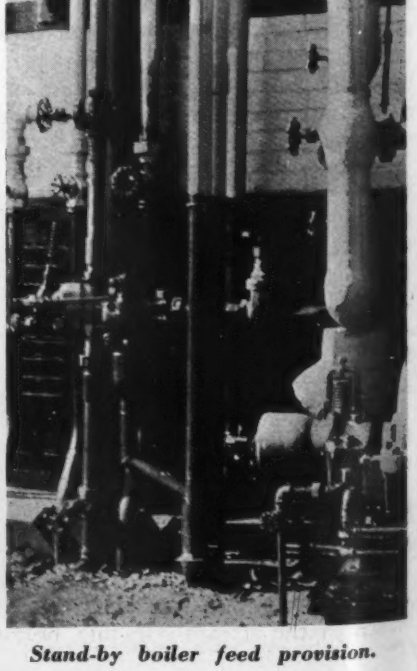
The following method has been found to be rapid, convenient, and accurate, requiring practically no attention once it is started. The required amount of water is measured into a volumetric flask, and a rubber stopper containing a pyrex glass tube approximately one half centimeter in diameter and five centimeters long is inserted in the mouth of the flask. After weighing the evaporating dish and placing it on a steam bath, the flask is carefully inverted over the dish and adjusted to proper height by means of a ring and stand. As the level of the water rises over the end of the tube, the flow will cease until the level again drops below the tube. A current of filtered air is then directed on the surface of the water. This results in a rapid, smooth evaporation with absolutely no danger of spattering and loss of contents. No attention is required after starting. This arrangement is illustrated in the accompanying diagram.

El Dorado, Ark. T.L.M.

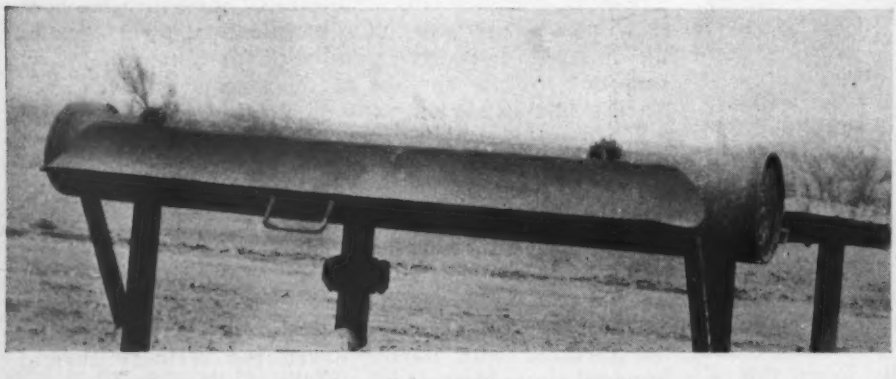
Insuring Boiler Feed

THE centrifugal pump finds wide application among refineries as boiler-feed unit, being able to handle the supply from the hot well advantageously; but on this service is apt to become air-bound if the water in the hot well flows through open returns from the various machines in which the steam is used.

To provide quick and positive priming



Stand-by boiler feed provision.



Drip funnel for unloading drums of gasoline gathered in the field.

of the centrifugal whenever needed, and give a stand-by means of supplying the boiler with water when the other unit kicks off, Premier Refining Company has adapted the type of high-pressure injector familiar in locomotive practice. A branch from the steam line supplying the turbine which powers the centrifugal pump carries steam to the injector. This is mounted on the boiler setting adjacent to the turbine drive. The discharge from the injector, carrying the water supply to the mud ring of the boiler, passes close to the outlet from the centrifugal and is connected to it with a valve which, normally closed, may be opened to put the full force of the injector's stream of boiler feed water against the centrifugal.

Due to the characteristic of centrifugal pumps, being able to run against full load, it is possible to prime the pump with the injector and let it run for some little time without being forced to shut down the injector—without the slightest danger of injury to either.

ELTON STERRETT.

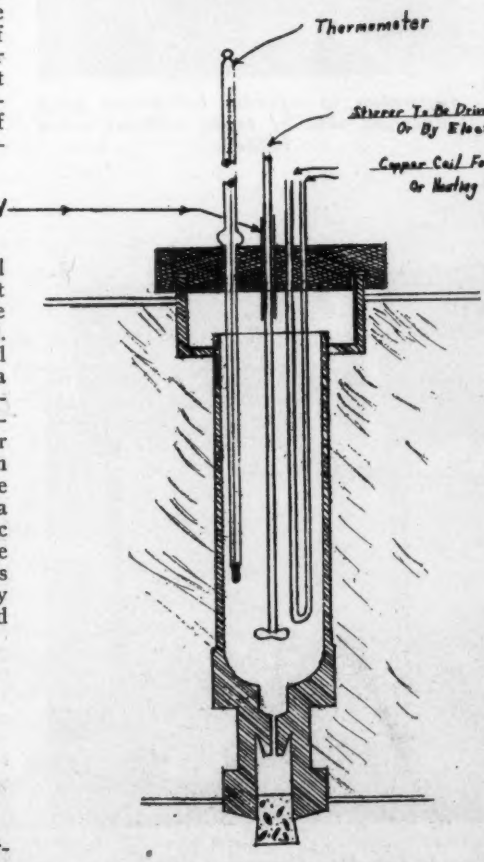
Longview, Texas.

Bringing Viscosimeter Charge to Temperature

ONE of the most time-consuming and tedious operations in the testing of petroleum oils is bringing of viscosimeter charge to the proper temperature. The usual methods introduce the charge into the viscosimeter at temperatures either too high or too low, and to either lower or raise these temperatures uses much time and energy in the form of tedious stirring and needless waiting. The device herewith illustrated effectively obviates these difficulties. As shown in the diagram the apparatus consists of a cover made of wood or other suitable material, a stirrer consisting of a small propeller blade at the end of a brass, bronze or other suitable metal rodding, and a coil made of small copper or brass tubing whose purpose is to either heat the charge with steam or cool it with water as the case may be. The operation of the device depends on the rapid circulation of the oil and the subsequent good heat transmission to or from the walls of the viscosimeter and the coil. The velocity of the steam in the coil very effectively heats the charge in a short time. If the required temperature is exceeded it may be quickly rectified by running water or compressed air through the coil. The stirrer is driven either by a compressed-air motor made from a cork, a few pieces of tin, and a compressed air jet; or by a small electric stirrer motor. This device requires the minimum of time and attention for its operation. At the end of each run it may be cleaned by dipping into naphtha, and then wiping with a clean rag.

HARRY VINOCH,

Beaumont, Texas.


Thermometer
Stirrer To Be Driven By Compressed Air Motor Or By Electric Motor
Copper Coil For Steam or Water For Cooling Or Heating the Charge
Stirrer For Stirrer Rod

Viscosity change to temperature

Electric Drill as Spot Surfacer

RARELY is a power-driven floor surfacer included in the average plant equipment, but for removing blisters in cement floor paint and the tapering down of the edges thus exposed an electric drill and a wire brush will do the job with a little help. The round brush, fitted to a mandrel adapted to the drill spindle, need be only large enough to hold the spindle end of the drill clear of the floor.

Mobility is afforded the rig by strapping an ordinary roller skate under the handle grip of the drill. When so equipped the operator is able to vary the pressure on the brush as demanded by the work at hand, and to move the machine readily over the floor, anchoring it for each spot to be trimmed with the toe of the right foot and the knee of his left leg.

One end supported on a child's roller skate, this electric drill drives a brush for cleaning paint or metal surfaces rapidly

Such a brush, drill powered, will prepare a floor for repainting by removing and bevelling all blisters and bare spots in less time and infinitely better than could four men, working with hand scrapers.

For cleaning tank plate and similar salvage work around a refinery the drill, if equipped with wire brush and roller skate support for the handle end of the frame, will be found to work easily and rapidly; being readily shifted as the job requires, and permitting the pressure to be varied to suit the material being cleaned.

ELTON STERRETT.

Longview, Texas.

Positive Start-Up Oiling

DIESEL power and pumping units which were allowed to stand for considerable periods between runs were observed to be noisy when again put in service, but this pounding, rattling and excessive vibration was accepted as part of the routine of starting a cold engine until a new engineer took charge of the plant.

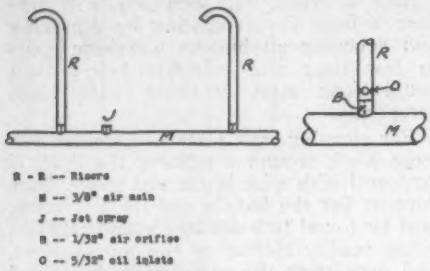
The mere unbolting of the inspection doors and the flooding of all bearings with a pump oil can—immediately prior to starting up—showed that the disturbance was caused by a lack of oil in crankshaft mains, connecting-rod and wrist-pin bearings, as well as piston-cylinder contacts in which there was metal-to-metal contact due to residual oil from the previous run having drained out or become segregated in places having maximum clearance, but such a procedure was out of the question in ordinary operating routine.

To provide a method which would flood the crankshaft bearings and spray oil over all other moving parts, the engineer ran a main of ⅜-inch pipe along the engine base, lying completely within the supply of oil carried in the engine sump. At spots adjacent to each main bearing a riser was attached, of ¼-inch copper tubing, formed to follow the bearing block and direct the flow directly into the aperture at the top of the bearing. Under one side of each connecting rod, at the crank throw, was fitted a short stub or nozzle, and the main connected to the air line used for starting the unit.

When starting, air was turned on the engine a portion found its way through the main "M" of the sketch, escaping through the 1/32-inch hole as at "B" and drawing oil in through the apertures "O" and through the risers "R", carrying it to the main bearings. At the same time, jets of air escaping through the stub risers "J" carried a spray of fine oil droplets against the joint between rod bearing and shaft, forcing lubricant into every void between metals. This same spray filled the crankcase space, depositing oil on the exposed ends of pistons and on such portions of the cylinder walls as were not covered by piston skirts.

Being connected to the end of the air starting line, this spray system was

operative only while the starting air was actually being admitted to the engine, and waste was in this way avoided. The temporary air pressure built up in the crankcase by the spray system was vented to the outside through the usual crankcase vent pipe, and was neither of sufficient pressure or duration to cause leakage along the shaft at ends of the engine base.

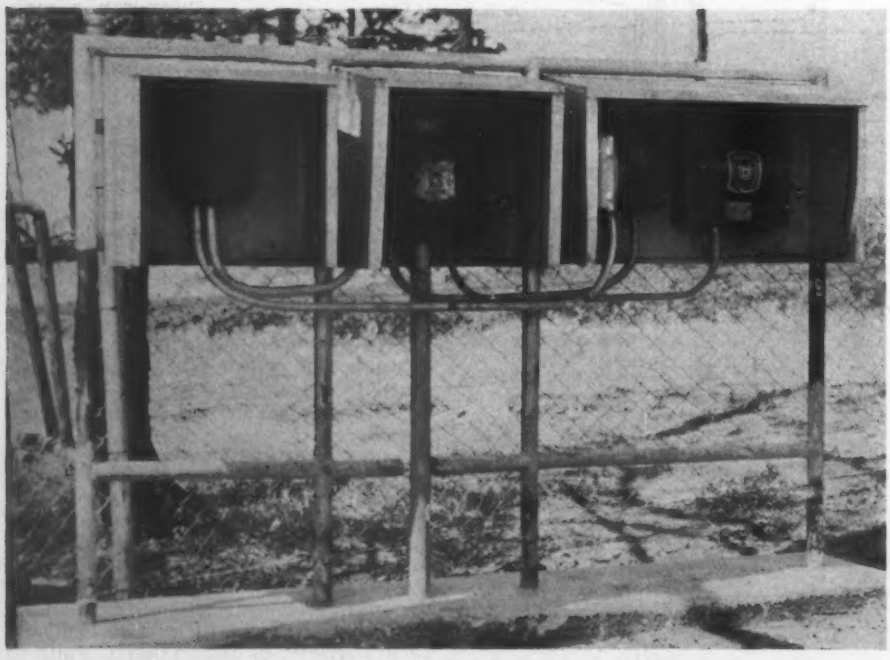


Positive start-up oiling

Manual Unit for Shorting Engines

IN making provisions for shut-downs when an emergency arises, Parade Gasoline Company has installed a series of manual switches located at a distance from the engine rooms in its gasoline plant in the south part of the East Texas oil field. Two stations were erected, one near the fence where the employes enter the yard, and another on the other side of the plant convenient to a gate in the fence. These installations are in addition to the usual mercury switches which operate automatically when conditions arise which require stopping of compressors.

Both units were wired to handle all magnetos attached to the engines, and are connected so that dropping one switch handle will make operation impossible. Safety was the idea back of the installation, which is intended to be used only in case of an emergency which requires that gas flow be immediately arrested. The ordinary type of knife switches were used such as are found in many switch board buildings. They do not require vapor proof or oil immersion units.



Manual controlled switches in plant of Parade Gasoline Company which may be used to render inoperative all engines in the compressor buildings.

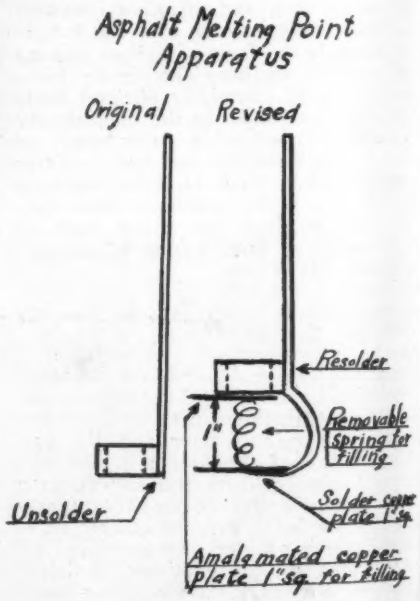
Plug Valve Remote Control

OPERATING vessels with plug valves installed near the walls above the reach of operators when standing upon the ground, Leonard Refineries, Inc., at Alma, Michigan, applied the principle of remote control to these valves by installing a special wrench made for them, attached permanently to the plugs. The outer end of the handle was drilled and an extension rod fastened to it, operated at right angles, with a yoke at the end of the rod for flexibility, through which a bolt was placed, securing the rod to the handle of the wrench. The lower end of the rod was equipped with a similar yoke, which in turn was bolted to a handle attached to the side of the tank at a convenient height for the operator. The travel of the lever on the tank is through an arc which enables the plug valve to be completely opened or closed, or, operated in a pinched position, depending upon the conditions encountered. The installation of several of these remote controls on various tanks makes ladders unnecessary. The operators can control the plug valves as well from the ground as if they were at the plug with the usual wrench.

Apparatus to operate lubricated plug valves on side of tanks without using ladders.

Revamped Asphalt Melting Point Apparatus

IN the use of the single ring and ball method for determination of the melting point of asphalts it is necessary to adjust the ring "just 1 inch from the bottom of the beaker." This adjustment takes time and unless one has a guide is subject to variance with the result that the melting points will not be comparable and in cases will be erratic. The apparatus however may be revamped at practically no expense and very little trouble which simplifies this matter, simplifies the cleaning as the beaker does not have to be cleaned and assures a constancy of the distance of fall which likewise assures comparable results for either control or comparison.



The ring is unsoldered from the supporting wire and resoldered about 1½ inches from the end of the wire. The projecting end is then flattened and a small plate of copper soldered to it. The copper plate and projecting wire are then bent with pliers so that the plate is parallel with the ring and 1 inch below it. Another copper plate about 1 inch square is then cut and held to the bottom of the ring with a small spring. This is for filling the ring with the asphalt and should be well amalgamated to prevent sticking. After the sample is chilled the spring and plate can be easily removed and the test made.

Wichita, Kansas, R. M. SANFORD.